JUN 29 1910

JOURNAL OF ELECTRICITY

POWER AND GAS

Devoted to the Conversion, Transmission and Distribution of Energy

Entered as second-class matter May 7, 1906, at the Post Office at San Francisco, Cal., under the Act of Congress March 3, 1879

VOL. XXIV NO. 26 | SAN FRANCISCO, JUNE 25, 1910 | PER COPY, 10 CENTS

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JOURNAL OF ELECTRICITY
POWER AND GAS
Devoted to the Conversion, Transmission and Distribution of Energy

VOLUME XXIV SAN FRANCISCO, JUNE 25, 1910. NUMBER 26

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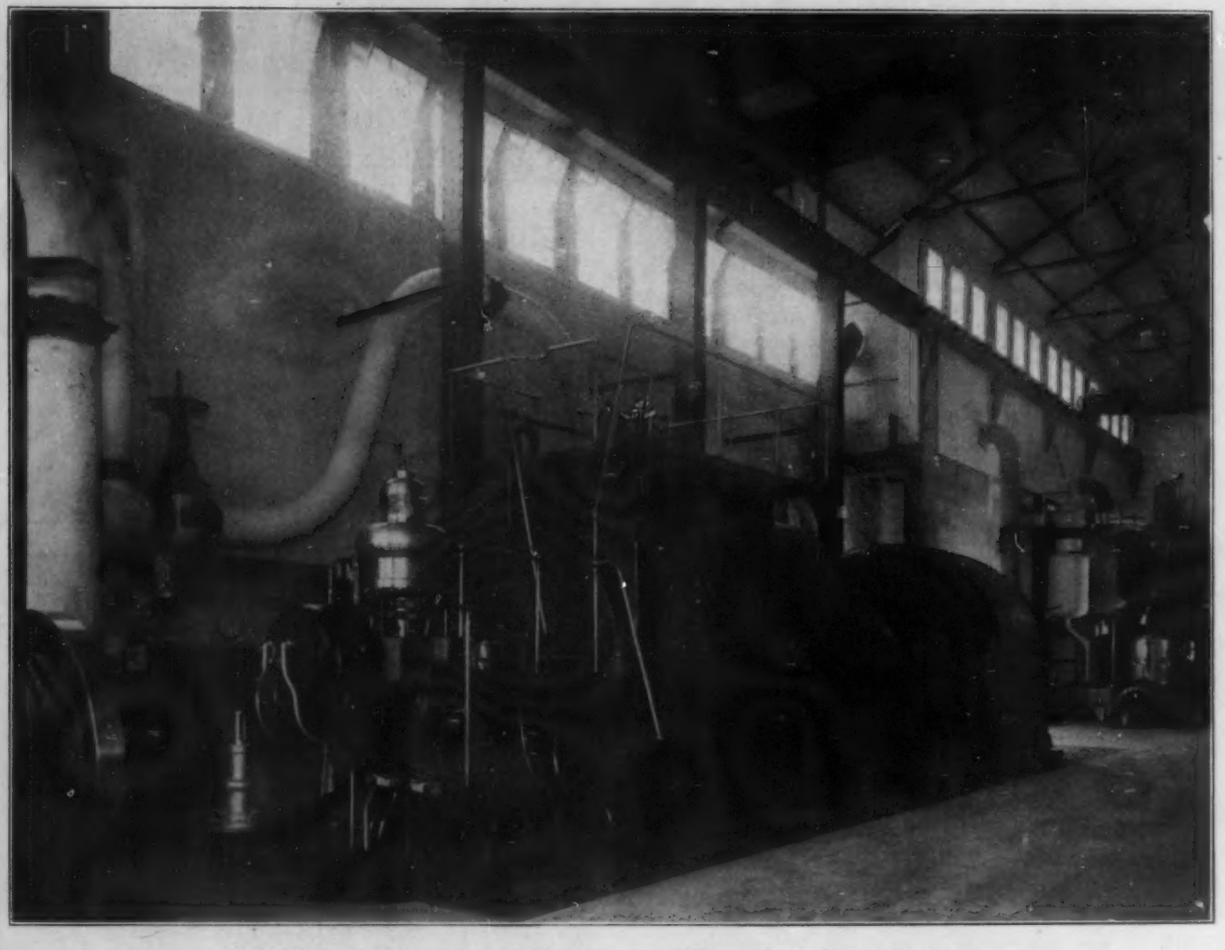
POSSIBLE IMPROVEMENT IN STEAM PLANT ECONOMY[1]

BY L. R. JORGENSEN.



10,000 kw. Westinghouse Parsons Turbine at Southern California Edison Plant at Los Angeles.

Economy is the keynote of present-day engineering. Of two power stations, the one which produces a kw.-hour the cheaper under like conditions, will generally be considered to be designed the better. In the development of the steam power plant during the last century, its efficiency has been raised from about 1 per cent to a little over 10 per cent; especially in the last fifty years has the development been rapid and steady. In this period our old earth has seen more progress in all technical branches than it saw in 6000 or more years preceding, due mainly to the fact that engineering has been based upon scientific principles.

An efficiency of 10 per cent seems rather low and still it is above the average. Shall the next ten years see this efficiency increased to 20 per cent? To analyze how this efficiency can be improved, it is necessary to

[1]Paper read before San Francisco Section A. I. E. E., June 24, 1910.

follow the different transformations in detail, the first being the combustion.

I. Boiler Room.

This is the chemical combination of the combustibles with oxygen, of which the conversion of the carbon into carbon dioxide is of the most importance, mainly because it constitutes by far the largest percentage of the fuel, and also because the analysis of this part of the transformation can be made visible at all times, thereby enabling the boiler attendant to follow what his coal pile is going through, and to get the maximum heat out of it.

The fuel may be of any kind and grade. We will consider only the most economical air supply, and are, therefore, mainly interested in the percentage of carbon in the fuel. Anthracite coal contains from 92.5 to 97 per cent carbon, oil an average of 84 per cent. The heating value per lb. of anthracite coal is from 14,500 to 14,800 B.t.u.; per lb. of oil it is an average of 18,000 B.t.u., and per lb. of carbon 14,500 B.t.u., the same as some grades of anthracite coal.

To transform 1 lb. of carbon to carbon dioxide ($C + 2O$) it is necessary to supply oxygen in proportion to the combining weights of the two substances. As the combining weight of carbon is 12, and that of oxygen 16, we must supply $\frac{2 \times 16}{12}$, or 2.67 lb. of O for each lb. of C. We use the atmospheric air, and as this contains 23 per cent of oxygen (77 per cent nitrogen), we must supply $2.67 \times \frac{100}{23} = 11.6$ lb. of air for the complete combustion of 1 lb. of carbon. The weight of this gas will be $11.6 + 1 = 12.6$ lb., of which $2.67 + 1 = 3.67$ lb. are carbon dioxide, or $\frac{3.67}{12.6} = 29.1$ per cent by weight.

As no instrument is on the market, which will indicate certain kinds of flue-gases in per cent of weight, we must reduce this to volume. The specific volume of carbon dioxide is 0.0909; of oxygen 0.125, and of nitrogen 0.143. We have then actual volume of oxygen $2.67 \times 0.125 = 0.334$; of nitrogen $(11.6 - 2.67)\ 0.143 = 1,2770$; of carbon dioxide 3.67×0.0909, and percentage of CO_2 by volume $\frac{0.333}{0.334 + 1.277} = 20.7$ per cent.

This is the maximum percentage of CO_2 the flue gases can possibly contain. We have considered pure carbon only. For coal, with 97 per cent carbon, the percentage of carbon dioxide would be about 20, and would decrease as the percentage of carbon in the fuel decreased, but for comparison it is sufficient to use carbon. As we never have complete combustion in an ordinary boiler, the percentage of CO_2 will always be less than 20.7. By means of a CO_2 indicator, it is possible to follow the chemical transformation of the fuel at all stages, and keep the efficiency of this transformation at a maximum for the kind and grade of fuel used.

Heretofore, the fireman had to go by his "feeling" entirely in operating the damper; now with a CO_2 indicator installed he has at all times a visible record of what he is doing; he changes his damper opening until the CO_2 instrument shows maximum percentage of carbon dioxide. It has been found that the damper must be operated more often, and but little at a time, in order to give maximum average percentage of carbon dioxide, or, in other words, to give maximum evaporation per lb. of fuel.

In order to show what would be the approximate increase in boiler efficiency by the introduction of a carbon dioxide indicator, it is only necessary to find the efficiency of combustion for different amounts of air supply and compare them.

If 1 lb. of carbon, or a certain kind of coal, is burned, 14,500 B.t.u. are liberated; with 11.6 lb. of air, just sufficient for complete combustion, the furnace temperature will be $\frac{14,500}{(11.6 + 1)\ 0.27} = 4260$ degrees F.

The specific heat of air varies with the temperature. At 32 degrees it is close to 0.24; at 266 degrees it is 2 per cent higher, and at 446 degrees it is 5.68 per cent higher than at 32 degrees, but the percentage of increase for such temperatures as exist in the boiler furnace is not known. Enough has been done, however, to show that at such temperatures the specific heat closely approximates to 0.3. Therefore, the average specific heat will be taken 0.27.

In almost all calculations of this kind the writer has observed the factor 0.2438 (or 0.2375) has been used for the specific heat of air; it seems more correct to use the average specific heat, as the entering air must be heated from around 32 degrees to the maximum furnace temperature. For 150 per cent air supply, we will have a furnace temperature $\frac{14,500}{(17.4 + 1)\ 0.27} = 2930$ degrees. For 200 per cent air supply we will have a furnace temperature of $\frac{14,500}{(23.2 + 1)\ 0.27} = 2218$ degrees. For 300 per cent air supply, we will have a furnace temperature of $\frac{14,500}{(34.8 + 1)\ 0.27} = 1500$ degrees.

To 100 per cent air supply corresponds 20.7 per cent carbon dioxide.

To 150 per cent air supply corresponds $\frac{20.7}{1.5} =$ 13.8 per cent carbon dioxide.

To 200 per cent air supply corresponds $\frac{20.7}{2} =$ 10.35 per cent carbon dioxide.

To 250 per cent air supply corresponds $\frac{20.7}{2.5} =$ 8.3 per cent carbon dioxide.

To 300 per cent air supply corresponds $\frac{20.7}{3} =$ 6.9 per cent carbon dioxide.

In practical operation boilers are often supplied with as much as 300 per cent of air, whereas they can be operated with 150 per cent if a CO_2 indicator is used. The reason is obvious. In the former case, the fireman is dependent upon his instinct; in the latter, upon what he sees with his own eyes, which is a better basis from which to work. This is clearly shown in Mr. Stott's paper on "Power Plant Economies," Curve 3 and 4, page 6, in the Transactions of the A. I. E. E. for 1906. The difference in efficiency in the above cases would be as follows:

For every lb. of air discharged at a temperature say 400 degrees abs. atmosphere, there is wasted $400 + 0.27 = 108$ B.t.u., taking again the average specific heat of air 0.27.

In case No. 1 with 150 per cent air supply. 17.4 lb. of air to 1 lb. of carbon, the waste is: $(17.4 + 1)\ 108 = 1985$ B.t.u., efficiency $\frac{14{,}500 - 1985}{14{,}500} = 0.864$.

In case No. 2, 300 per cent air supply, 34.8 lb. of air to 1 lb. carbon. $(34.8 + 1)\ 108 = 3860$ B.t.u.; efficiency $\frac{14{,}500 - 3860}{14{,}500} = 0.735$. Or a difference of 12.9 per cent, which saving was brought about by the use of a CO_2 indicator.

On boilers using oil the saving would probably not be as great, as they can be fired with less average excess of air due to the fact that the conditions of combustion are more constant; the damper does not need to be operated so often. For low grades of coal the saving would be greater.

Comparing this gain in efficiency with the gain resulting from installing an economizer, we find this latter raises the efficiency less, and at the same time its first cost is from 10 to 20 times higher than the former. Still it is considered good practice to install economizers where the load factor is above 25 per cent and where coal is above $2.50 per ton.

Taking 2218 degrees as the furnace temperature (200 per cent air supply), 500 degrees as the temperature of the gases as they strike the economizer, and this to lower the temperature 100 degrees, we have the percentage of the total heat absorbed by the economizer:

$\frac{100}{2218 - 500} = 5.84$ per cent. For higher per cent of air supply, this would increase; for lower per cent it would be less.

In cutting down the air supply from 300 to 150 per cent (that is from 200 per cent excess to 50 per cent excess) the boiler efficiency has not only been raised 12.9 per cent, but the size of the smokestack has been cut in half, an additional important gain, for the simple reason that only half volumes of flue gases have to be handled. If the air supply is insufficient, or the mixture of air and flue gases incomplete, each atom of carbon will not be able to find two atoms of oxygen, but will combine with one atom of O only, forming carbon monoxide, and for each lb. of carbon burned this way there will only be liberated 4400 B.t.u., or $\frac{4400}{14{,}500} = 30.3$ per cent of the total heat. This would seldom occur in regular operation, although some percentage of the gases may be CO instead of CO_2, and this the indicator would not show; therefore, the actual air supply cannot be accurately calculated from the instrument readings.

II. Prime Movers.

If indicator cards taken from the three cylinders of any first-class triple expansion engine are replotted to the temperature entropy scale, it is plainly seen that the cards taken from the two first cylinders cover nearly 80 per cent of the ideal area, the third, or low pressure cylinder diagram, however, covers 45 per cent only.

As the economy of a first-class triple expansion engine is practically the same as the economy of a first-class turbine, it is at once evident that the high pressure cylinders (high and medium) can transform the heat in the steam into work more efficiently than a steam turbine; and with low pressure the turbine is so much ahead of the last engine cylinder that they finally come out even, or the turbine slightly ahead.

This fact is demonstrated in several power plants, where high pressure steam engines exhaust into turbines, and they then work on that portion of the cycle where they have their greatest efficiency. To see clearly why this is so, we will follow the action of the steam in the two cases.

Suppose we calculate a 500-kw. turbine, assuming that it will use 15 lb. dry saturated steam per h.p.-hour at 150 lb. gauge pressure, gives a steam consumption per hour of $670 \times 15 = 10{,}000$ lb.

We consider an impulse turbine first and choose 10 nozzles in two groups of five each, located diametrically opposite.

This will give $\frac{10{,}000}{10} = 1000$ lb. of steam per nozzle per hour. $\frac{1000}{3600} = 0.278$ lb. per second per nozzle.

Velocity of steam flowing into a space of less pressure is practically constant as long as this lower pressure is 58 per cent or less of the initial. This accounts for the fact that turbines do not lose so great a proportion in efficiency by changes in back pressures. The pressures in the different stages change with the load, but not enough to appreciably change the velocity of flow.

From steam tables we find the velocity of flow to

be 1481 ft. per second, initial pressure being 165 lb. abs., final pressure $165 \times \frac{58}{100} = 96$ lb. abs. with 2.5 per cent moisture in the steam at that pressure. Volume of 1 lb. of steam at 96 lb. abs. = 4.53 cu. ft., then area of throat of nozzle $= \frac{4.53 \times 0.975 \times 0.278 \times 12^2}{1481} =$ 0.119 sq. in. If the turbine must be able to carry 50 per cent overload, the area must be $0.119 \times 1.5 = 0.178$ sq. in., or 0.47 in. dia.

We want to design a turbine with four stages, and the pressure in the first stage to be 75 lb. abs. If saturated steam at 150 lb. gauge expands adiabatically to 75 lb. abs., we will have 95 per cent dry steam left. Volume of 1 lb. of steam at 75 lb. abs. is 5.71 cu. ft.; velocity of steam expanding from 150 lb. gauge to 75 lb. abs. = 1780 ft. Area of orifice =

$$\frac{5.71 \times 0.95 \times 0.278 \times 12^2}{1780} = 0.122 \text{ sq. in.};$$

for 50 per cent overload this area must be $0.122 \times 1.5 = 0.183$ sq. in. (cross section is made rectangular).

The different bucket angles are now found by means of a velocity diagram drawn to scale. The nozzles are made to include angles of 20 degrees with the wheel plane and the circumferential velocity of the wheel taken at 300 ft. per second.

The relative entrance velocity measures 1500 ft. and includes an angle of 24 degrees with the wheel plane; this is to be the angle of the first and last bucket element in the first row of buckets, the intermediate portion to be a smooth curve. This will allow the steam to enter upon the bucket without impact and leave it without commotion.

The velocity given up into work in this wheel is 1780 — 1500 = 280 ft.; as no expansion has taken place the volume of steam is the same, but, as the velocity at the exit is 280 ft. less than at the entrance, the outlet area must be increased in proportion $\frac{1780}{1500}$, that is, the bucket length must be increased this amount.

The absolute velocity of the steam jet entering stationary buckets No. 1 is taken the same as the relative entrance velocity to moving buckets No. 1 = 1500 ft. per second, which is only correct if we had no friction losses. However, if we use superheated steam, this will compensate for the friction losses, as we will start with a slightly higher velocity than the 1780 ft. per second.

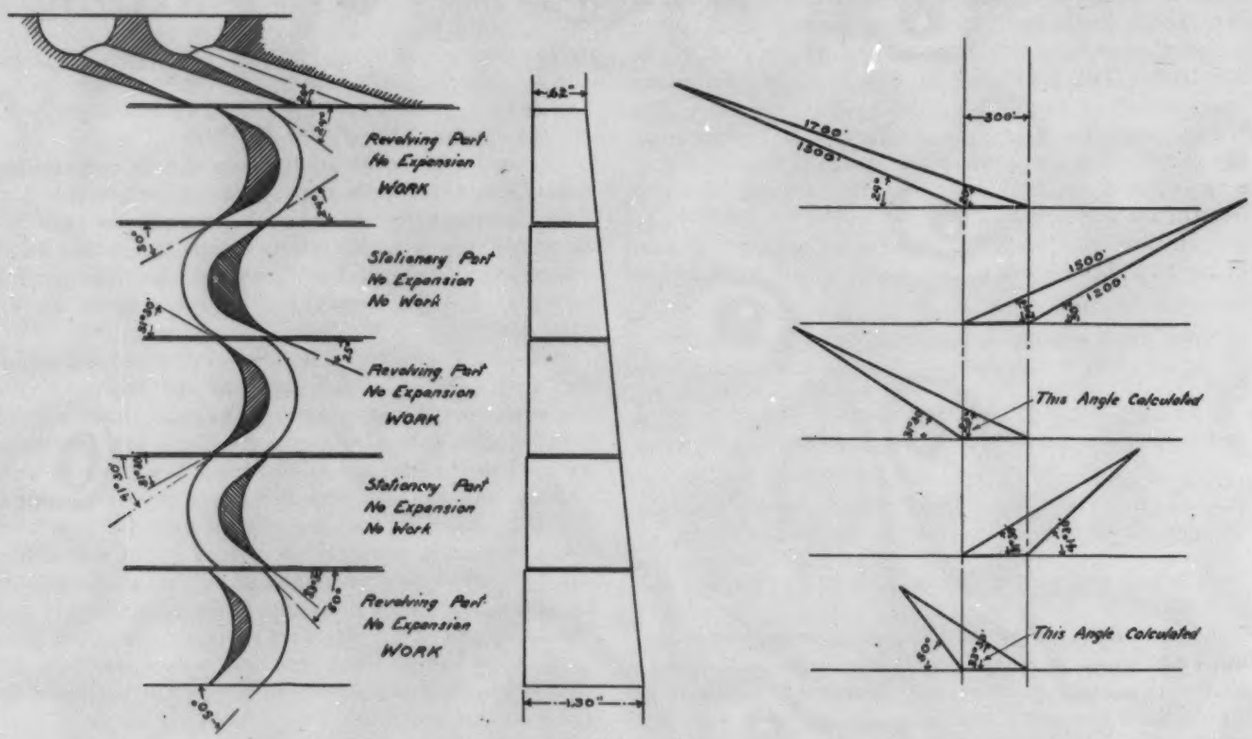


Fig. 1.

Relative entrance velocity to stationary buckets No. 1 is found to be 1200 ft. and the angle it includes with the wheel plane to be 30 degrees; this will be the angle of the first bucket element.

No velocity is lost in going through this row of buckets, still the length of the buckets has to be increased in the same proportion as above to afford a smooth passage for the steam, and while the area must remain the same, the distance between blades at the exit must be smaller than at the entrance; this is also of advantage, as it affords an opportunity to decrease the angle between the last bucket element and the wheel plane. In this case the angle is calculated to be 25 degrees.

The absolute velocity of the steam entering the second row of moving buckets will, therefore, form an

angle of 25 degrees with the wheel plane, and the same calculation is repeated for the rest of the bucket rows.

It is seen that the bucket angles are getting larger as we go down and less work is taken up by each set of wheels, so we soon find a limit, where it does not pay to put on more rows.

The other three stages are calculated in the same way. Generally it is of advantage to take up more than one-fourth of the total work in the first stage, the steam volumes are smaller and the pressure in the turbine casing can be kept lower.

In the reaction turbine we have expansion taking place in both stationary and moving buckets. The main difference between the flow diagram for this kind of turbine and that shown in Fig. 1 is that the relative velocity is greater than the absolute velocity in the former case, and vice versa in the latter. The average velocity can thereby be kept smaller, thus reducing the friction loss, but the loss through leakage is evidently greater on account of the difference in pressure between all wheels, putting the two types on an equal basis as far as economy is concerned.

One lb. steam at 165 lb. abs. has a volume of 2.72 cu. ft. One lb. steam at 28 in. vacuum has a volume of 349.7 cu. ft. Saturated steam expanding adiabatically between 165 lb. absolute and 28 in. vacuum contain about 78 per cent dry steam at the end; the total expansion ratio would, therefore, be $\frac{349.7 \times 0.78}{2.72} =$ 100. If the steam expanded from 165 lb. absolute to 29 in. vacuum, the expansion ratio would be about 200.

The above turbine is to make 1500 r.p.m. and will have a diameter of $\frac{300}{1500/60} =$ 3 ft. 10 in. The ten nozzles of the first stage would cover about 15 per cent of the circumference, and as the steam expanded in the different stages, more nozzles would be put on, their cross sectional area increased and the bucket lengths made to correspond herewith to take care of the increased steam volume.

The last stage would have nozzles all around the circumference and would have buckets as long as practical: this is really the condition which determines the diameter of the turbine.

If a steam engine should take care of this expansion, 100 to 200 times the original volume, it would have impractically large dimensions for the last cylinder. As now designed, the steam can only be expanded to say 24 in. vacuum, and there is not much need for condensers, which will give higher vacuum than can be used. We get too little extra work at the expenditure of large quantities of cooling water. In the large cylinder we have the greatest friction and cooling losses; in the low pressure turbine we have the least as compared with the high pressure portion of the turbine.

The discs revolve in a nearly perfect vacuum, which makes the loss due to windage small, and if the steam friction loss is proportional to the specific weight of the steam, this loss is many times the smallest in the low pressure turbine.

The loss due to leakage through clearances is also proportional to the density and therefore much the largest in the high pressure turbine. In this the proportion of clearance to length of bucket may be as 0.1 in. to 1 in.; in the low pressure turbine this proportion is 0.1 in. to 5 in. average. The density of steam is about fifty times greater in the first stage than in the last, but it must also be remembered that leakages in the first stage take place only on 15 per cent of the circumference, whereas in the last stage the leakage takes place around the whole circumference. In the two high pressure cylinders the steam is working with a high efficiency because they can take care of the expansion, the friction and cooling losses are not large, due to the relative small dimensions and the increase in economy is nearly proportional to the rise in boiler pressure. This is not the case with turbines where leakage losses increase rapidly with higher pressure.

In order to obtain the most economical conditions, we will take a two cylinder compound reciprocating engine and feed it with a boiler pressure as high as has been found practical, say 225 lb. gauge and 200 degrees superheat (nearly all reciprocating engine-driven ocean liners use this pressure), and let this expand down to 14.7 lb. gauge in the engine; from there it is exhausted through a superheater, which also takes out the puffs, into a low pressure steam turbine, where it expands to 28 in. vacuum.

The flue gases will have a temperature of about 550 degrees F. for this high boiler pressure; therefore, the intermediate superheater can be put in the flue between the boiler and the smokestack like the economizer, the flues being run underneath the power house floor to facilitate short connections between reciprocating engine, superheater and turbine. Such a superheater would be much cheaper than an economizer for the simple reason that it has to stand only a few pounds pressure above or below the atmosphere.

Steam of 225 lb. gauge and 200 degrees superheat expanding adiabatically becomes saturated at 45 lb. absolute and at the end of its expansion we have only 93 per cent dry steam left. Expanding in a steam engine we would have less left, say 91 per cent, or 10 per cent less, which would be available for the superheater.

Take 2 lb. of coal as necessary to generate one kw.-hour. Burned with 200 per cent air supply we would have available in the flue gas: $2\,(23.2 + 1)\,450 \times 0.27 = 5880$ B.t.u. (Flue gas temperature 550 degrees, outside air 100 degrees). Take 15 lb. of steam as necessary to generate one kw.-hour. To superheat the exhaust from the engine 100 degrees would then require $15 \times 0.91 \times 0.55 \times 100 = 750$ B.t.u., 0.55 is average specific heat of superheated steam at this pressure. To re-evaporate 10 per cent, or 1.5 lb., at 14.7 lb. absolute would require $1.5\,(965 + 100 \times 0.55) = 1530$ B.t.u. Then the active flue gas temperature would be lowered $\frac{750 + 1530}{5880} =$ 38.8 per cent. This would still leave a temperature difference between flue gases and outside air of $450 - \frac{450 \times 38.8}{100} =$ 276 degrees for an

economizer to utilize, or for creating draft in the chimney.

The entropy diagram, Fig. 2, shows what work there is available in the stream. It is calculated as follows:

The entropy of water at 100 degrees (561 degrees absolute) $2.3 \log \frac{T}{493} = 2.3 \log \frac{561}{493} = 0.129$.

The entropy of water at its final temperature 397 degrees (225 lb. gauge) $2.3 \log \frac{(397 + 461)}{493} = 0.55$.

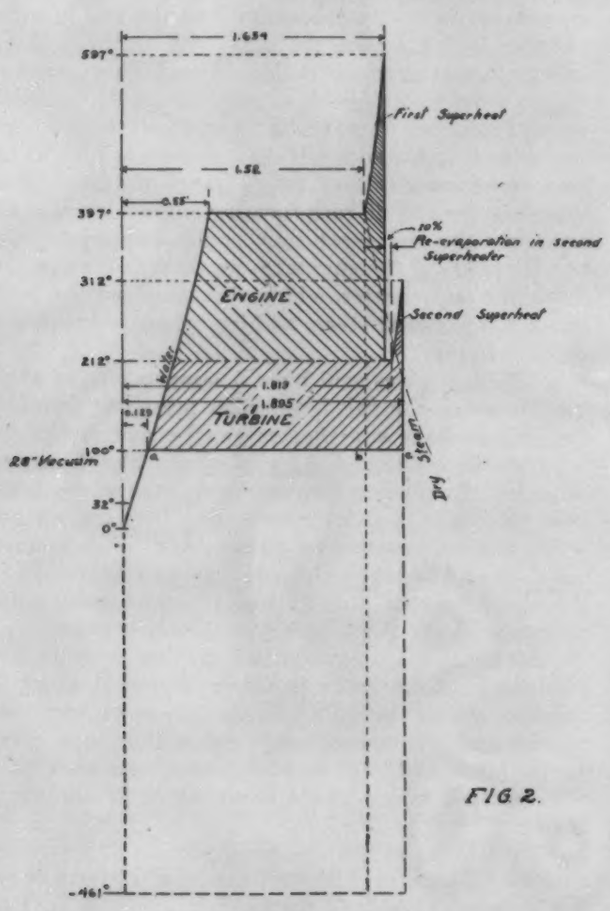


FIG 2.

The entropy of dry saturated steam at 225 lb. gauge:

$$\phi = 2.3 \log \frac{T}{493} + \frac{r}{T} = 0.55 + \frac{833}{858} = 1.52.$$

r = latent heat of vaporization = 833 × T = 397 + 461 = 858 degrees.

The additional entropy of superheated steam 200 degrees superheat starting at 397 degrees.

$$\phi s_1 = 2.3 \times c \log. \frac{Ts}{T} = 2.3 \times 0.65 \log \frac{(858 + 200)}{858}$$

= 0.134.

c taken = 0.65 = specific heat of superheated steam starting at 397 degrees.

The total entropy of superheated steam 200 degrees superheat starting at 397 degrees.

$\phi + \phi s_1 = 1.52 + 0.134 = 1.654$.

Re-evaporation 10 per cent.

Total entropy of steam after re-evaporation = $1.654 + \frac{10}{100} \times 1.654 = 1.819$.

The additional entropy of superheated steam 100 degrees superheat starting at 212 degrees.

$$\phi s_2 = 2.3 \times 0.55 \log \frac{Ts_2}{T_2} = 2.3 \times 0.55 \frac{\log 773}{673} =$$

0.076.

$Ts_2 = 673 + 100 = 773$.

$T_2 = 212 + 461 = 673$.

c taken = 0.55 = specific heat of superheated steam starting at 212 degrees.

Total entropy of steam superheated 100 degrees starting at 212 degrees = 1.819 + 0.076 = 1.895.

Total heat in 1 lb. of saturated steam at 225 lb.; gauge pressure by steam tables 1203 B.t.u.; heat in water at 100 degrees (28 in. vacuum) = 68 B.t.u.

Additional B.t.u. for superheating twice and re-evaporation = 0.65 × 200 + 0.55 × 100 + (1.819 — 1.654) 673 = 296 B.t.u

B.t.u. lost = area below the 100 degree line = 561 × (1.895 — 0.129) = 990 B.t.u.

$$\text{Efficiency} = \frac{1203 - 68 + 296 - 990}{1203 - 68 + 296} = \frac{441}{1431} =$$

31.0 per cent.

If we take the combined efficiency of engine and turbine at 75 per cent, we get the actual proportion between the work theoretical in the steam and the work taken off the shaft:

$$31 \times \frac{75}{100} = 23.2 \text{ per cent.}$$

A figure which is not realized in any plant today, but which it seems entirely possible to realize and which will be realized some day when fuel gets expensive enough to make the inconvenience of two different kinds of units a necessity.

Municipal electric plants, according to the census reports for 1907, number 1252, as compared with 815 in 1902 and as compared with 3602 commercial plants. Of these 150 were in the North Atlantic States; 158 in the South Atlantic; 727, North Central; 166, South Central; and 51, Western. Most of the municipal stations are in places of small population, nearly seven-eighths of the total number being located in places of less than 5000 population and less than 3 per cent in places having a population of 25,000 and over. The output, in kilowatt hours, of the municipal stations in 1907 was 289,462,788, as compared with 195,904,439 in 1902, an increase of 47.8 per cent. The commercial stations in this respect in 1907 increased 141.1 per cent.

THE HISTORY OF GAS-LIGHTING IN ALAMEDA COUNTY.

BY E. C. JONES.[1]

E. C. Jones.

Although San Francisco as early as 1854 was furnished with illuminating gas through the energies of Peter Donahue and others, it was not until 1867 that Oakland, then the second largest city in California, was supplied with this useful commodity. The overflow population of San Francisco had not up to that time discovered the attractions of suburban life, and transportation across San Francisco bay was, at best, hazardous. Oakland's wonderful climate, its miles of oak-covered lands, and its contiguity to San Francisco, began to prove inviting to the tired business men of the metropolis. By 1864 Oakland commenced to take on the aspect of metropolitanism. Attention was called to its great harbor possibilities existing in the estuary of San Antonio, which divides Oakland from Alameda. As a land-locked harbor it attracted, even at that time, the attention of the government, which commenced taking measures to improve it by erecting a training wall and deepening it by dredging. This work made available on each side of the estuary large tracts of hitherto submerged lands, and they became convenient sites for manufacturies. The originators and promoters of the Central Pacific Railroad, recognizing the value of this land as a terminus for the proposed transcontinental railroad, soon became a large owner of the property bordering on the bay on the west and the estuary on the south.

December 9th, 1865, a franchise was granted by the Oakland City Council to Joseph G. Eastland, at that time secretary of the San Francisco Gas-Light Company, and William W. Beggs, the San Francisco company's engineer. This franchise gave the privilege of laying gas mains in the city of Oakland, and fixed the gas rate at $7.50 a thousand cubic feet.

Following the granting of this franchise, the Oakland Gas-Light Company was incorporated June 12th, 1866, and the franchise was transferred to it by Joseph G. Eastland and William W. Beggs.

The first directors of this Oakland company were William W. Beggs, Joseph G. Eastland, and Anthony Chabot, a well-known citizen of Oakland, interested in the city's water supply. Anthony Chabot was elected the first president, and Joseph G. Eastland, the first secretary, of the company.

It was impossible at that time to locate a gas works upon the estuary lands. There obviously would have been the proper place for them, but the purchases made by the Central Pacific Railroad Company and the peculiar waterfront grants given to others by the city of Oakland rendered the estuary lands unavailable then. So a lot on the northeast corner of First and Washington streets, within a half block of the waterfront, was purchased as a site for the gas works, and Tyler Sabbaton, at that time one of the engineers of the San Francisco Gas-Light Company, was employed to prepare plans and specifications for the building of the gas works. Henry Adams was elected superintendent of these works. He was a resident of Sacramento. Later he was superintendent of the Napa Gas Works, and thereafter, until his death, was superintendent and manager of the Stockton Gas Company. When the Oakland company was reorganized in April of 1867, H. H. Haight, who had been Governor of the State of California, was elected president.

The first installation of the works consisted of a holder having a capacity of 5000 cubic feet, and one bench of three iron retorts housed in a brick building approximately 20x30 feet. The purifying house contained four purifiers, each 8x10x3 feet. It is recorded that in 1866, the first night that gas was turned on in the city of Oakland, the consumption for the night was 3000 cubic feet. In 1866 Van Leer Eastland succeeded Henry Adams as superintendent, and he continued in that office until his death, September 8th, 1894. In 1870 a second holder, having a capacity of 25,000 cubic feet, was erected. The maximum consumption had reached 20,000 cubic feet a day. From 1870 until 1874 very rapid progress was made in the laying of mains and the obtaining of customers. In 1873 it became necessary to enlarge not only the retort-house capacity but also the capacity of the purifiers and the storage tanks. Iron retorts had long since been discarded for those of clay. These clay retorts were imported from the East in benches of fives and were substituted for benches of threes.

Holder number three was built in the fall of 1873, and it had a capacity of 150,000 cubic feet. It remained in use until 1904, when it was discarder only by reason of the removal of the gas works from its original location.

The first dividend of the company was declared in January of 1874. From that day, until the consolidation with the California Gas and Electric Corporation in January of 1903, the Oakland company continuously paid dividends of twenty-five cents a share on the capital stock, with the exception of a period of eighteen months in 1884-5, when expenses of new construction caused the suspension of dividends.

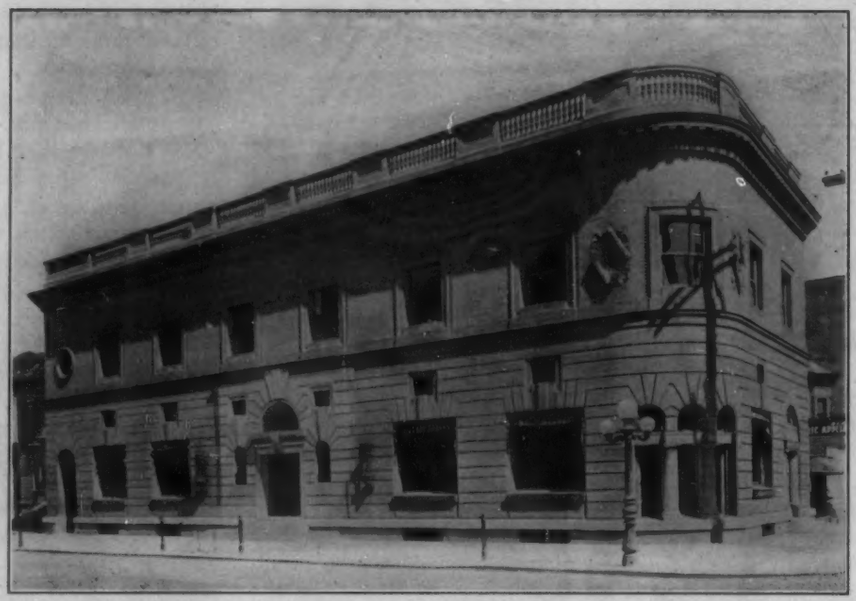
Having faith in the future growth of Oakland and foreseeing the needs of the enlargement of its plant, the company bought, in 1875, what is known as city block number 3, which is bounded by Jefferson, Grove, and Second streets. This was the site of the palatial home of Domingo Ghirardelli, the chocolate manufacturer. His was a place noted for a wonderful display of magnificent statuary, which he had collected during his frequent visits to Europe. In 1875, also, J. West Martin, a prominent Oaklander, was elected president to succeed ex-Governor Haight, who had died in the early part of that year.

In 1877 it became necessary largely to increase the capacity of the plant, and to use the old Ghirardelli home block. A bonded indebtedness was therefore incurred in the sum of $250,000 to provide money for the improvements. Holder number 4, having a capacity of 450,000 cubic feet, was erected, together with a purifying house having four purifiers, 20x24 feet each. The capacity limit of the plant as enlarged became fixed at 500,000 cubic feet. The output at that time was approximately 150,000 cubic feet a day. It was supposed then that the ultimate requirements of the plant had been reached, but the future determined otherwise.

During all of the ten years following the establish-

ment of the Oakland company, both the city of Alameda and the town of Berkeley, which had become the State University center, had been growing. Therefore in 1877 the directors of the Oakland company determined to extend the service of gas to both these neighboring communities. In that same year, anticipating future necessities, a part of the waterfront lying between Jefferson and Castro streets, was purchased.

During the first month of the operation of the Oakland company the records show that there were only twenty-three consumers connected with the mains. But in 1878, after eleven years' development, the total number had grown to 1801.



Office Building of Oakland Gas Light and Heat Company, Thirteenth and Clay Streets

In 1879 a gas holder was erected in Alameda. A pipe connection from the Oakland works at First and Washington streets was made across the estuary and into Alameda over the company's own drawbridge, which had been built on Webster street. The year 1879 marks the first installation in the United States of high-pressure gas service, as a pressure approximating eight pounds was carried upon the mains that ran from the works in Oakland over to the holder in Alameda. This high-pressure system was subsequently extended to include the distribution to customers, and was produced by means of a Connelly governor, which, until recently, continued in daily use.

The year 1879 also marks the introduction into California of gas stoves. Joseph G. Eastland, then the secretary of the Oakland company, had purchased, during a visit to Europe, a large invoice of Fletcher stoves. These stoves, after some difficulty and persuasive arguments, were put in various Oakland homes.

In 1880 the Lowe process was installed, Oakland being the second city in California to make use of this method of manufacturing gas. The oil for the manufacture of the gas was purchased from the Pacific Coast Oil Company at the rate of $2 a barrel.

In 1881 the town of Berkeley was first lighted by gas. But about that time the attention of the entire world had been called to the introduction of electric lighting. Foreseeing possible annihilation in competition with this new form of lighting, the Oakland company, with its usual progressive spirit, determined to secure such rights as it could to the ownership of electric service. In 1883 it secured from the Thomson-Houston Company exclusive rights to use in the cities of Oakland and Alameda and the town of Berkeley that company's apparatus, and in 1885 completed a building and installed two 25-arc machines.

In 1886 Oakland got her first cable-car line. Prior to that time transportation about the town had been by means of the now obsolete horse-car, which still survives as a California relic only in San Francisco and San Buenaventura.

In 1887, the Edison light having been perfected for general purposes, the Oakland company purchased the right to use the Westinghouse alternating system, and in January of the following year installed a 50-ampere machine having initial voltage of 1000.

In May of 1888 the company decided to erect an electric-lighting station on waterfront property at First and Grove streets. And in September of that year it purchased from the Westinghouse company two 1000-volt alternating-current generators of 50-ampere capacity. This was the first installation of incandescent electric-lighting in Oakland.

During 1889 Welsh anthracite coal was first used in the making of Oakland's water-gas. Then holder number 2 was erected in Alameda. In 1892 holder number 7, having a capacity of 700,000 cubic feet, was built on block number 3 by the Stacey Manufacturing Company.

The Oakland company, in July of 1892, moved into its new office building, then just completed, at Thirteenth and Clay streets.

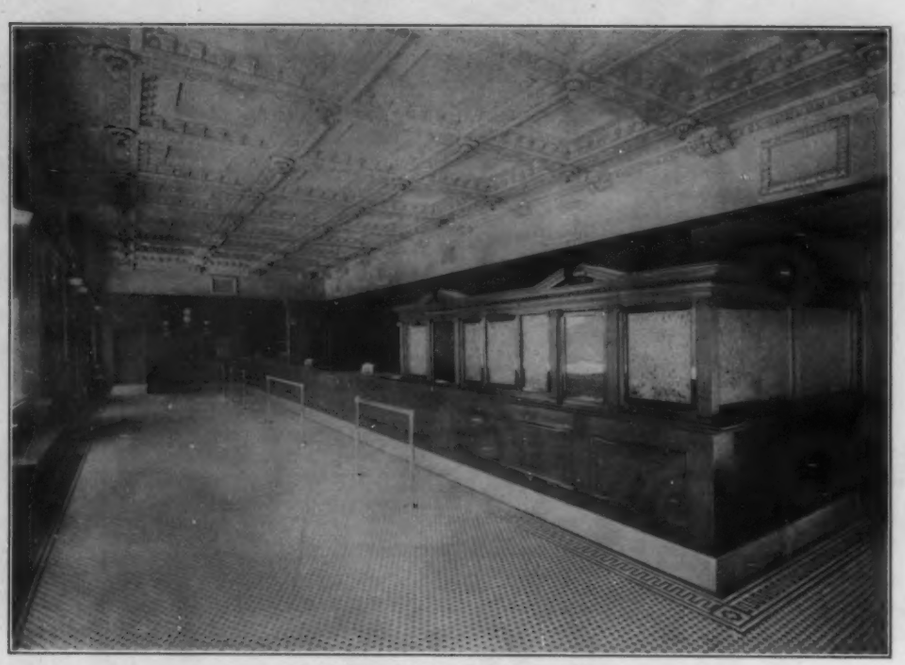
In 1893 the Station B electric-light works was erected. It contained two Fitchburg engines, each of 400 horsepower with boiler equipment, all installed by the Risdon Iron Works.

In December of 1894 the company imported bituminous coal from Japan for the manufacture of coal-gas. Earlier in the year a branch office had been established in Alameda.

During all the years following May of 1874, when he first entered the employ of the Oakland Gas-Light Company, John A. Britton was intimately associated with the success of the concern, occupying successively various positions of trust prior to his election to the secretaryship in August of 1883.

In September of 1894, following the death of Van Leer Eastland, who had for many years been superintendent of the company, John A. Britton was elected superintendent and engineer in addition to his old position as secretary.

In 1895 the Berkeley Electric-Lighting Company was purchased and absorbed. November 23d, 1895,



Interior of the Oakland Office.

Joseph G. Eastland, the secretary of the Oakland company, died, and January 2d, 1896, John W. Coleman, the president, also passed away.

In August of 1898 John A. Britton was elected president and engineer of the Oakland Gas Light and Heat Company.

During the spring and summer of 1902 the California Gas and Electric Corporation entered into a contract with the Oakland Gas Light and Heat Company to supply the Oakland company with oil-gas. Station B at First and Market streets was therefore selected for the manufacture of the oil-gas. This station had originally been erected as a gas works by the Equitable Gas Company in opposition to the Oakland Gas Light and Heat Company.

The first oil-gas ever manufactured in Oakland was made at Station B, September 1st, 1902. Oil-gas proved so successful that several additions had to be made to the plant. By September 11th, 1904, all of the gas supplied to the city of Oakland was what is known as crude-oil water-gas, and it was manufactured at Station B.

The gas business in Oakland increased normally until the earthquake of 1906. Then the enormous influx to Oakland of population from San Francisco created such a demand for gas that the gas delivery was increased from 563,000,000 cubic feet in 1905 to 970,000,000 cubic feet in 1906. This was at first considered a gain in business due to feverish conditions that would later shrink, but the increased send-out of gas was sustained and even augmented during the two subsequent years. Oakland reached its maximum output of gas December 21st, 1908, when that one day 6,835,000 cubic feet were furnished.

In 1907 the company constructed, at First and Grove streets, a 2,000,000-cubic-foot gas holder resting in a steel tank. During that same year additions were also made to the generating capacity of Station B to provide for the increased demand for gas.

Oakland is now provided with modern gas-making machinery and ample storage capacity to meet the demands of a city of its continued rapid growth.

GAS EXPERIENCE WANTED.

Leon B. Jones wants some experience, not for himself but for the members of the Pacific Coast Gas Association who will meet at Los Angeles on September 20, 21, 22, 1910. Mr. Jones is the editor of the experience department of the Association and promises to treat the name of the sender confidentially if so desired. Everybody is invited to send his contributions on gas experience to Mr. Jones at 445 Sutter Street, San Francisco.

OAKLAND'S GAS SYSTEM.[1]

BY KEMPSTER B. MILLER.

The gas for lighting, cooking and heating is supplied to the entire city of Oakland from a plant in the southern part of the city, near the bay shore. The Oakland gas plant was a pioneer in the employment of high-pressure mains throughout the system, for insuring a uniform pressure at the more remote points. The gas supplied is manufactured by a crude-oil-water process which seems to be peculiar to the Pacific Coast and more particularly to the territory surrounding San Francisco. This method of manufacture results in a rapid production of the gas, which in turn renders a large storage capacity unnecessary. This method of rapid production and small storage capacity would, unless properly safeguarded, be likely to result in a variable quality of gas from time to time, and this point was made the subject of particular investigation.

Numerous tests were made, extending over a period of approximately three weeks, to determine the illuminating and heating properties of this gas. In the illuminating tests a standard amyl-acetate lamp was used as a primary standard, this lamp having been calibrated for accuracy by the Bureau of Standards at Washington and at the Armour Institute of Chicago just before use. The photometer used was the standard Bunsen type using improved Lummer-Brodhun screen. The calorific measurements were made by means of a Junkers Calorimeter, which was carefully cleaned, overhauled and adjusted before and during the tests. All devices used in connection with these instruments were carefully checked for accuracy.

Illuminating Quality.

The results of tests made nearly every day for a period of about three weeks to determine the lighting

[1]Extract from Report on the Gas and Electrical Conditions of the City of Oakland.

qualities of the gas indicate that the gas had an average illuminating power of 21.9 candle power when burning at the rate of 5 cubic feet an hour and at atmospheric conditions corresponding to a temperature of 60 degrees Fahr. and a barometric pressure of 30 inches. The variation in candle power was from 24.6 c.p. as a maximum to 18.5 c.p. as a minimum, under the above conditions.

The times of making the tests on the different days ranged from 8:45 A. M. to 9:30 P. M. As the average candle power was 21.9 and as the minimum of all the tests was about 18.5 c.p., my conclusion is that the gas furnished during this period was satisfactory from the standpoint of its illuminating quality. As a basis of comparison I will refer to the following table as showing the candle power of the gas as required by the various State Commissions or by other bodies in the following cities:

New York City	22-c.p.	Buffalo, N. Y.	18-c.p.
District of Columbia	22-c.p.	Auburn, N. Y.	18-c.p.
Detroit	18-c.p.	Syracuse, N. Y.	18-c.p.
All Massachusetts cities	16-c.p.	Plattsburg, N. Y.	18-c.p.

As the average candle power of the Oakland gas was 21.9, only one-tenth candle power below the requirement for New York City and the District of Columbia, and as the minimum for Oakland, 18.5, was above that of the other cities in this list, I am of the opinion that the gas measured in Oakland during this period is all that can reasonably be required in point of candle power.

Heating Quality.

Tests for determining the calorific or heat-giving qualities of the gas were likewise made nearly every day for about three weeks. The results of these tests show that the gas has an average calorific power of 613.8 B.t.u. per cubic foot at an atmospheric condition corresponding to a temperature of 60 degrees Fahr. and a barometric pressure of 30 inches.

During the tests the calorific power of the gas averaged from 642.6 B.t.u. as a maximum to 574.1 B.t.u. as a minimum. The change between these limits, like the candle power, was sometimes rather rapid, owing, no doubt, to the quick production and low storage capacity of the system.

As compared with these results for heating quality, I will quote from the rules of the Wisconsin Railway Commission, which commission exists for the purpose of regulating the methods employed and results obtained by public service corporations in that State:

"Rule 8:—The company, furnishing gas which within one mile radius from the distribution center gives a monthly average total heating value of not less than 600 B.t.u. with a minimum which shall not fall below 550 B.t.u., may be considered as giving adequate service as far as the heating value of the gas is concerned."

As the average calorific power of the Oakland gas, 613.8 B.t.u., is well above the average requirement (600 B.t.u.) of this commission, and as the minimum, 574.1 B.t.u., of the Oakland gas is well above the minithat the Oakland gas, as judged by this standard, is of good calorific power. Perhaps a requirement of 600 B.t.u. would come as near to representing the standard calorific requirement for good gas as can be given, and with this standard the Oakland gas compares favorably.

Throughout the tests no serious changes of pressure were noticed, the service being satisfactory in this respect. The process employed in the manufacture of this gas seems also to give a gas flame that is somewhat whiter in quality than the ordinary coal gas, which is a desirable feature. Furthermore, no criticism is to be made as to the objectionable products of combustion, as the gas seems to burn without objectionable smoke or soot. The gas, when escaping, has a pungent odor, amply sufficient as a safeguard against its escapement without detection.

THE ADVANTAGES OF SUPERHEATED STEAM.

BY E. H. FOSTER.

The advantages of superheating steam will be readily recognized, when it is considered that steam used for power plants is merely a vehicle for conveying heat to the steam engine. As such a vehicle, steam is at its best when it is free from water and also when it is performing the conveying act at the highest efficiency. Steam being a gas is used as such and the presence of water introduces a disturbing element. Provisions are made for handling the steam as a gas, but when water is present provision must also be made for handling water as a liquid. The elimination of water greatly simplifies the problem of designing and maintaining a steam power plant.

The increase of efficiency by superheating steam was discussed by Rankine in his work on the steam engine. By raising the temperature at which steam receives its heat efficiency is increased without producing a dangerous pressure. According to the law of efficiency of thermodynamic engines the heat transformed into mechanical energy bears the ratio to the whole heat received by the fluid as the range of temperature is to the absolute temperature at which the heat is received, as follows:

$$E = \frac{T_1 - T_2}{T_1 + 461.2}$$

Thus, the more heat supplied per unit of volume of steam to the engine, the more work can be obtained from the engine, and the increase of pressure having a practical limit this extra heat is to be obtained by superheating the steam.

The diminished density of the steam employed to do the work lessens the back pressure, or, as commonly expressed, improves the vacuum. This also applies to the air and vapor which are carried with the steam and further expanded by the increased heat and are consequently contracted to a much less volume, when chilled by striking the cooling surface of the condenser. Thus the air pump has less work to do.

The prevention of condensation of steam on entering the cylinder and of further condensation during

the early stages of expansion is obtained by superheating and without the use of steam jackets.

Steam jackets are wasteful and inefficient because they give contact only with the steam next to the walls of the cylinder, which necessitates carrying a high temperature in the jackets, in order to produce any effect on the steam which is in contact with the piston. Steam jackets are wasteful because of the heat which they impart to the exhaust steam and to the steam in the cylinder when the piston is near the end of the stroke and its pressure is low. At such times a transfer of heat takes place when the difference in temperature between the steam in the jacket and the steam in the cylinder is at its maximum point. This heat is all lost in the exhaust.

This is especially true of engines having a pause at the end of the stroke, such as direct acting pumps. We may, therefore, summarize the practical advantages of superheating as economy in boiler power, economy in engine power, economy in steam consumption, economy in fuel consumption, economy in sizes of pipes, valves, and fittings in the steam mains, better vacuum in condenser and longer life of the machinery.

The economy in boiler power is shown by the fact that superheated steam does from 10 to 20 per cent more work. This is brought about by the greater amount of heat contained in each pound of steam leaving the boiler and also by the efficiency of the steam in doing its work. It is not an infrequent occurrence in a plant containing five boilers to see one boiler put in reserve and the remaining four doing the work, after superheaters have been installed.

Economy in engine power has been frequently demonstrated by such tests as those made on the Rice & Sargent Corliss engines at the Milburne Mills in Philadelphia and at the American Sugar Refining Company in Brooklyn, also on the McIntosh & Seymour engines at the Edison Electric Light Works in Boston, which show that the economy of operation when steam is superheated is greatly improved, not only at normal load, but in much larger proportion when the engineer is running on partial load or on overload, the tendency being to equalize the water rate throughout a wide range of loads. This is also true in the case of steam turbines, as has been demonstrated by a test of the Westinghouse-Parsons machines at Hartford and other places and also on numerous Curtis turbines.

Economy in steam consumption has been frequently demonstrated in practice. Tests made at the Maryland Steel Company in their power plant, after installing the superheaters in connection with their Altmann & Taylor boilers show a saving of 12 per cent of the steam used by the plant on its regular work. The fuel used in this case is blast furnace gas. At the Wisconsin Steel Company in South Chicago the installation of superheaters in connection with their twenty Sterling boilers heated by blast furnace gas, resulted in the elimination entirely of the use of coal in the works, where it had been formerly necessary to supplement the steam generated by the blast furnace boilers from an auxiliary boiler house where coal was used.

A recent test of the vertical triple expansion water work engines built by the Camden Iron Works for Cincinnati show a saving of 8½ per cent fuel used by superheated steam of 100 degrees at the engines. In this case there were four engines tested, two with saturated and two with superheated steam. The test of each engine lasted 144 hours continuously. The average duty on saturated steam was 152,000 and on superheated steam 165,000 foot pounds, per hundred pounds of coal burnt under the boilers and superheaters.

At the Hyde Park plant of the American Sheet Steel Company, the reduction in the cost of fuel per ton of plate output was about 15 per cent, comparing the average of the four months after the superheaters were put in with the four corresponding months of the previous year. Most of these examples are taken from the experience of the past year or two. Numerous other important tests extending back several years have been a matter of record for several years past, and the number add the same conclusions with regard to the advantages of superheated steam.

Economy in fuel consumption has frequently been found after superheaters were put in to be greater than the saving in steam. This is doubtless due to the increased efficiency of certain boilers by adding the superheating surface. It may safely be estimated that where attached to the boilers superheaters will operate with an efficiency close to 100 per cent, the only loss being a slight additional friction of steam in passing through the superheater, which may be considered a negligible quantity. It is usually found that with coal at $3 per ton superheaters will save the cost of their installation in about two years.

In power plants it is desirable to have the auxiliaries operated with superheated steam, because in these more wasteful types of steam cylinders, the proportional saving is great. No difficulty need be anticipated from the use of steam at a temperature not exceeding 500 degrees F. in any type of steam engine with Corliss, slide, piston or gridiron valves.

Economy in the sizes of pipes, valves and fittings in the steam mains is due to the fact that the friction of superheated steam in pipe lines is much less than saturated steam and smaller pipes may be generally used.

Better vacuum in condenser is explained above, as demonstrated by practice at the Maryland Steel Company's plant, where fully 1 in. better vacuum is obtained on the central condensing apparatus when superheated steam is used.

Longer life of the machinery is obtained on engines, because keeping cylinders free from water improves lubrication, allowing the oil to keep on the surface and the risk from accidents and damage by the water in the cylinder is eliminated.

The engine is more readily put in service, as the warming up process is simplified and particularly in the case of steam turbines the wearing on the blades due to the presence of water in the steam is eliminated. Much difficulty has been experienced of late in reference to steam turbine blades being cut into deep at their base where they join the rotor, caused by the moisture carried with the steam. This has never occurred where superheated steam was used.

THE WATTHOUR METER.

BY WM. M. SHEPARD AND ALLEN G. JONES.

(Continued.)

CHAPTER VIII.

RATES.

Birmingham (Alabama) Railway, Light & Power Co.

The consumer hereby agrees to pay the company, monthly, within ten days after presentation of bills, for said incandescent light service at the base rate of twelve cents per kilowatt hour, as measured by meter or meters to be furnished and installed by the company, subject to the following discounts:

LIGHTING RATES.

On monthly bills under			25	k.w.h.	10	%
"	"	" over	25	"	15	%
"	"	" "	150	"	20	%
"	"	" "	250	"	25	%
"	"	" "	400	"	30	%
"	"	" "	500	"	35	%
"	"	" "	1,000	"	37½	%
"	"	" "	1,500	"	40	%
"	"	" "	2,000	"	42½	%
"	"	" "	2,500	"	45	%
"	"	" "	3,000	"	47½	%
"	"	" "	3,500	"	50	%

The consumer agrees to pay the company a net minimum monthly bill of ($.....) .....Dollars as a readiness to serve charge.

POWER RATES.

Discount for Monthly Usage.

500—1000	k.w.h. per month	10%	discount	
1000—2000	" " "	12%	"	
2000—3000	" " "	14%	"	
3000—4000	" " "	16%	"	
4000—5000	" " "	18%	"	
Over 5000	" " "	20%	"	

In addition—

10 to 15	k.w.h. used per h.p. installed				4%	discount
15 — 20	" " " "	"	6%	"		
20 — 25	" " " "	"	8%	"		
25 — 30	" " " "	"	10%	"		
30 — 35	" " " "	"	12%	"		
35 — 40	" " " "	"	14%	"		
40 — 45	" " " "	"	16%	"		
45 — 50	" " " "	"	18%	"		
50 — 55	" " " "	"	20%	"		
55 — 60	" " " "	"	22%	"		
60 — 65	" " " "	"	24%	"		
65 — 70	" " " "	"	26%	"		
70 — 75	" " " "	"	28%	"		
75 — 80	" " " "	"	30%	"		
80 — 85	" " " "	"	32%	"		
85 — 90	" " " "	"	34%	"		
90 — 95	" " " "	"	36%	"		
95 — 100	" " " "	"	38%	"		
Over 100	" " " "	"	40%	"		

10% additional for off peak service.

The San Francisco Gas & Electric Co., of San Francisco, Cal.

Lighting Rates.

All current delivered to the consumer shall be registered by a meter or meters installed and owned by the Company and the rate and minimum charge shall be as follows per meter:

per k.w.h.							k.w.h.
8	cents	if the monthly consumption be			less than		79
7	"	"	"	"	from		80— 129
6½	"	"	"	"	"	"	130— 189
6	"	"	"	"	"	"	190— 244
5¾	"	"	"	"	"	"	245— 309
5½	"	"	"	"	"	"	310— 374
5¼	"	"	"	"	"	"	375— 449
5	"	"	"	"	"	"	450— 549
4¾	"	"	"	"	"	"	550— 674
4½	"	"	"	"	"	"	675— 849
4¼	"	"	"	"	"	"	850—1099
4	"	"	"	"	"	"	1100 or over

The consumer agrees to pay the company a net monthly minimum bill of $1.00 for each meter installed, provided the bill for current consumed at the above premises, does not equal or exceed the said sum of $1.00 per month.

The consumer further agrees to pay a minimum of $1.50 per month, for each horsepower in motor or motors installed, provided the bill for current consumed does not equal or exceed the said sum of $1.50 per horsepower per month.

Power Rates.

All current delivered to the Consumer shall be registered by a meter or meters installed and owned by the Company and the rate and minimum charge shall be as follows per meter:

Per 1000		If the monthly consumption									
9	cents	is above the minimum and			less than 2,000 w.h. per 16 c.p. lamp.						
8.55	"	shall be from			2,000 to 3,000	w.h. per 16 c.p. lamp.					
8.1	"	"	"	"	3,000 to 4,000	"	"	"	"	"	
7.65	"	"	"	"	4,000 to 5,000	"	"	"	"	"	
7.2	"	"	"	"	5,000 to 6,000	"	"	"	"	"	
6.75	"	"	"	"	6,000 to 7,000	"	"	"	"	"	
6.3	"	"	"	"	7,000 to 8,000	"	"	"	"	"	
5.85	"	"	"	"	8,000 to 9,000	"	"	"	"	"	
5.4	"	"	"	"	9,000 or over	"	"	"	"	"	

Per k.w.h.		If the monthly consumption				
5.25	cents	shall be from			375 to 649	k.w.h.
5	"	"	"	"	650 to 924	"
4.75	"	"	"	"	925 to 1,199	"
4.50	"	"	"	"	1,200 to 1,474	"
4.25	"	"	"	"	1,475 to 1,749	"
4	"	"	"	"	1,750 or over	"

The consumer agrees to pay to the company a net monthly minimum bill of $1.00 for each meter installed, provided the bill for current consumed at the above premises does not equal or exceed the said sum of $1.00 per month.

The consumer further agrees to pay a minimum of $1.50 per month, for each horsepower or fraction thereof in motor or motors installed, provided the bill for current consumed does not equal or exceed the said sum of $1.50 per horsepower or fraction thereof per month.

From the data given above, a very good general idea can be gained of the fixing and application of lighting and power rates throughout the United States, though of course local conditions may cause a wide variation from the figures given.

(To be continued.)

CENTRAL STATION STATISTICS.

The commercial and municipal central electric light and power stations in the United States in 1907 numbered 4714; reported $1,096,913,622 as the cost of construction and equipment; earned $175,642,338, of which $169,614,691 was for electric service, including $125,755,114 for lighting; expended $106,205,149; employed 12,990 salaried officials and clerks, who were paid $11,733,787, and also 34,642 wage-earners, who received $23,686,537; operated 10,150 primary-power machines, with 4,032,365 horsepower capacity; had 12,173 dynamos, with a kilowatt capacity of 2,709,225; and their output, in kilowatt hours, was 5,862,276,737. Of the total number of lamps wired for service, there were: Arcs, 555,713; incandescent, 41,445,997; and other varieties, 162,338.

Comparing the proportion of population with that for the number of stations, the proportion of stations was larger than that for population for the North Central and Western divisions and smaller for the North Atlantic, South Atlantic, and South Central divisions. One of the most pronounced features of the central-station industry is the large percentage showing for the Western division, which in 1907, having less than 5,000,000 population, as compared with the population of upward of 11,000,000 and 16,000,000 for the South Atlantic and South Central divisions, respectively, reported a greater primary horsepower and larger dynamo capacity and more incandescent lamps wired for service than the latter two divisions combined. In per capita showing, the North Atlantic division was second in rank, the North Central third, the South Atlantic fourth, and the South Central fifth.

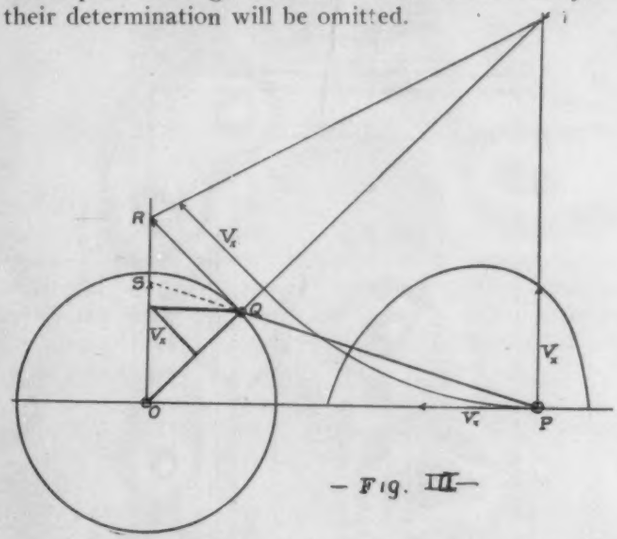
THE MECHANICS OF THE STEAM ENGINE.

(Continued.)

The component velocities of the crank-pin parallel with the vertical and horizontal axes may be found by constructing the parallelogram of forces with (QR) as the diagonal. (See figure III.)

The resultant and component velocities of any other point in the crank may be determined similarly, the resultant being parallel in direction with QR and proportional in amount to the distance of such point from the center O. That is, parallels to QR drawn between OR and OQ will give the direction and velocity of their points of intersection with OQ.

The velocities of intermediate points in the connecting rod may be readily determined by combining the angular velocity about (P) with the linear velocity of (P). Since these velocities are not of great interest to the practical engineer the construction necessary to their determination will be omitted.



— Fig. III —

The accelerations of the various parts of the engine chain are somewhat more difficult to understand than were the velocities.

Acceleration is the term adopted to convey the meaning of velocity change. Suppose a train to be moving at a speed of ten miles per hour. We say then, the velocity is constant and hence the change in velocity is zero, or, there is no acceleration.

Now suppose again that this train is not moving at constant speed, but is gaining speed such that, were its velocity measured one minute later than the above instant, it would be found to be fifteen miles per hour. The velocity change has been from ten miles per hour to fifteen miles per hour and this change has taken place in one minute. We say, therefore, that the acceleration has been five miles per hour during this minute, or five miles per hour per minute.

When considering the velocity of the crank-pin we learned that it was, for any instant, directed along the tangent to its orbit, or the circle it describes; and if the engine were running at a given number of revolutions per minute the magnitude of the velocity were constant. The direction, however, was changing uniformly. This velocity may be said, therefore, to have an angular acceleration.

Let us consider this acceleration. At the beginning of the head-end stroke, the velocity of the crank-pin in a vertical direction, or parallel with the Y axis, is constant and equal to the circumferential velocity of the pin. The horizontal component of the velocity, on the other hand, is zero at the end of the stroke. As the pin passes through the first quadrant to the position directly above the shaft, the component velocities vary; the vertical from its maximum to zero, and the horizontal from zero to the maximum, which value it assumes when the tangential velocity is horizontal as at the highest point in the circle.

The components of the acceleration have followed the velocity changes during this period. The vertical component at the beginning is zero. At the top of the circle it is a maximum and is downward, or negative, in direction. Between these two points the vertical component has increased gradually from zero to this maximum. Similarly the horizontal component of acceleration has decreased from its maximum at the end of the stroke to zero at the top of the circle.

Figure IV shows these component accelerations for a point Q in the quadrant, and their resultant is shown extending inward along the radius. It will be seen that the resultant acceleration is always directed toward the center of the circle.

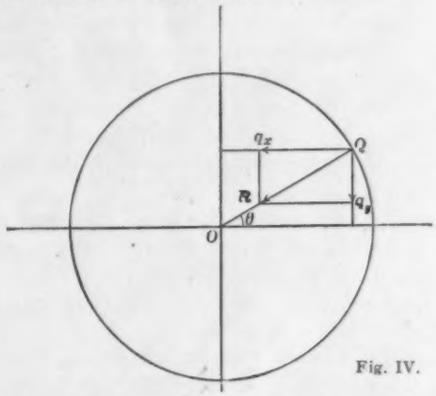


Fig. IV.

So long as the speed of rotation is constant these are the only accelerations with which the crank-pin is concerned. To accelerate any mass of material there is required a definite force proportional to the product of the mass and the acceleration. This is the centripetal force which the hub of a wheel exerts upon the spoke to hold the rim in its curved path.

The acceleration of other points in the crank is proportional to the distances of such points from the shaft center. These may be graphically drawn in a diagram similar to Figure III.

The vertical acceleration of the cross-head is zero.

The horizontal acceleration, however, is somewhat complex in its variations.

At the beginning of the head-end stroke, for instance, the velocity is zero, but as the crank-pin traverses the first few degrees of its path the cross-head begins to travel quickly and reaches a maximum velocity at a point where the connecting rod nears the tangency line of the crank orbit. During this interval the acceleration has decreased from a maximum at the beginning of the stroke where the velocity change was greatest, to zero at the point of maximum velocity (where the velocity change is for the instant zero).

The acceleration during this period follows the velocity changes beginning at a maximum and diminishing to zero at the point of greatest velocity.

CALIFORNIA OIL FUEL.

BY R. F. CHEVALIER.

Gas Analyses.

As already shown, the gases resulting from the combustion of oil are Carbon Dioxide (CO_2) Water (H_2O), Oxygen (O) and Nitrogen (N). If combustion is not perfect, combustible gases such as Hydrogen (H) and Carbon Monoxide (CO) will be present. In gases resulting from the combustion of oil CO rarely exists. The writer has never found more than ½ of 1% of this gas though dense clouds of smoke were issuing from the stack, owing to insufficient air supply.

By examination of the products of combustion we are able to ascertain the various constituents of the gases and determine whether there is a sufficient or over supply of air for combustion.

Following are some general remarks upon the analyses and measurement of gases taken from Hemple's Gas Analyses:

For the analysis itself various methods, corresponding to the nature of the gases, suggest themselves. The gases may be separated.

1. By successive absorption of the different constituents and the volumetric determination of each.
2. By absorption and subsequent determination by titration or weighing.
3. By combustion and the volumetric or gravimetric determination of the products.

Under all circumstances, however, the first operation is the measuring of the gas.

From the nature of a gas it is clear that its quantity can generally be better determined by measuring its volume than by ascertaining its weight. Hence one of the most important operations in gas analysis is the measurement of gases.

The volume of a gas is influenced by pressure, temperature and the tension of the liquid present.

By Boyle's law the density and the pressure of a gas are proportional to each other.

According to Gay-Lussac's law, gases expand 1/273 of their volume at 0° for each degree of temperature.

The tension of the confining or absorption liquid causes an increase of volume. This increase is dependent upon the temperature, is independent of the pressure, and varies with the chemical nature of the liquid in question.

To reduce a gas volume, measured in a moist condition, to the volume which it would occupy in a dry state at 0° C and 760 mm. pressure, the following formula is used: b is the observed barometric pressure, t the temperature, e the maximum tension of aqueous vapor at this temperature, and V the observed volume:

$$V_0 = V\frac{b-e}{760\,(1+0.00367\,t)}$$

In very exact work corrections should also be introduced for the expansion of the mercury and glass of the barometer.

Only those volumes can be directly compared with one another that have been reduced to equal pressure and temperature, the tension of the liquid being also allowed for.

Parallel gas measurement can be carried on under—

1. Varying pressure, varying temperature and varying volume.
2. Constant pressure, constant temperature and varying volume.
3. Constant temperature, varying pressure, and contant volume.
4. Constant pressure varying temperature, and varying volume.

In the first case the gas volumes found must be reduced to like temperature and pressure. In the second and third the resulting volumes can be directly compared, since density and pressure are directly proportional.

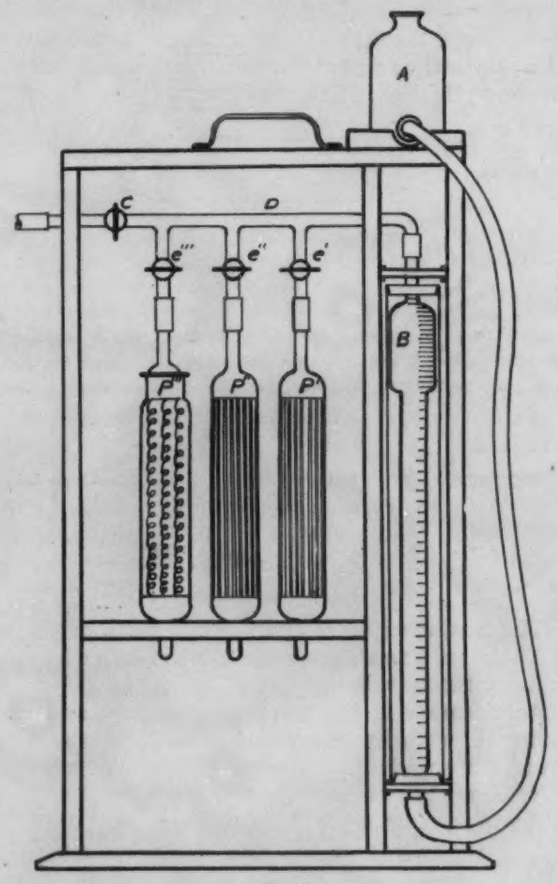


Fig. 1.

Volumetric method of gas analysis is the one in general use and for which there are various types of apparatus. For combustion gases the apparatus employed should be such that the degree of accuracy is within one per cent and at the same time should be portable, convenient and easy to manipulate. The apparatus of Orsat, a description of which follows, fulfills these conditions.

The apparatus (Fig. 1) consists of the leveling bottle A, the measuring burette B, which is water jacketed, the absorption pipettes P' P'' P''' and connecting tube D.

The absorption pipettes are in pairs connected at the bottom by a U tube (Fig. 2). The absorption side P contains small glass tubing to offer more absorption surface. Connections between the measuring

burette B and the pipettes P′ P″ P‴ are made by the glass stop cocks e′ e″ e‴, the pipettes and connecting tube D being joined by rubber tubing. At C is a three-way glass cock through which the sample of gas is drawn into B. Through the spindle of the cock, connection may be made to the atmosphere whereby air or gases in the apparatus may be discharged.

Preparation of Apparatus.

The glass stop cocks are removed and carefully cleaned and a small quantity of vaseline rubbed over them to prevent sticking.

The absorption pipettes are filled with their respective reagents, the liquid being equalized at about ⅝ of their capacity. The burette B is filled with pure water and the bottle A partially filled. The reagents

Fig. 2.

in the pipettes are then adjusted to a point on the stem of the connecting capillary tubes midway between the top of the rubber connections and the glass cocks e′ e″ e‴. This is done as follows: all the cocks are closed with the exception of the one connecting the burette B to the pipette in which the reagent is to be adjusted.

Bottle A is lowered very slowly until the reagent is brought to the point above indicated and the cock is then closed. After adjusting the reagent in all the pipettes in the above manner, burette B and the tube connecting to bottle A are completely filled with water. This is accomplished by opening C to the atmosphere and allowing the air in B to be expelled, at the same time raising the leveling bottle A. A small quantity of water should remain in the latter. The water jacket surrounding B should then be filled with water. In adjusting the reagents, care should be exercised that none of the liquid or water enters the connecting capillary tube above the stop cocks, also that none of the reagent mixes with the water in B. The apparatus is now ready to receive the sample of gas.

(To be continued.)

TRANSFORMER CONNECTIONS.

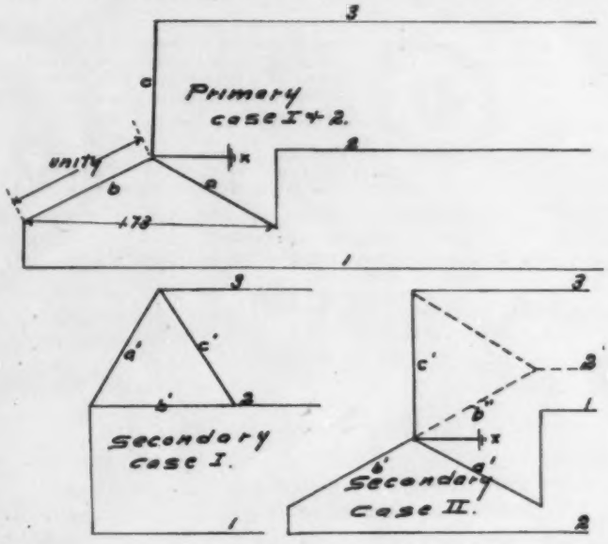
Question: Two banks of transformers, No. 1 and No. 2, operating on a "three-phase system Y connected on high side, Δ on low side (neutral grounded), one transformer in No. 1 bank breaks down. Now, No. 1 bank is out of commission as far as running in parallel with No. 2 is concerned. What I want to know is, can No. 1 be connected up in any way to run singly? CHAS. WINTERS.

Manton, Cal.

Answer: Regarding your question as to the operation of two transformers on a three-phase system to give three-phase on the secondary, under the hypothesis mentioned we would state as follows:

If one of a bank of three transformers (connected star on the primary and delta on the secondary) is disabled, it is possible to obtain three-phase current by simply disconnecting the injured transformer from the line on both high and low-tension windings. On the high-tension side the ground (X) will carry back to the power house transformers the unbalanced current load, while in the secondary winding a simple open delta condition will exist.

If the above transformers were connected delta delta, it is perfectly evident that taking out one transformer would not interrupt this service. If the transformers were star connected on high and low side, three-phase current cannot be obtained by disconnecting the third transformer, as it is obvious that when two phases are in service on the primary side that the same phase displacement would obtain in the secondary. It, therefore, would become necessary to reverse the connections of one of the phases on the secondary so that the phase displacement between it and the other leg of the open delta will be but 60 degrees.



By so doing, a true three-phase current would be obtained, but its value would be lower than the secondary voltage with three transformers in service, the new voltage being $\frac{1}{1.73}$. It would then be necessary to reconnect all the distributing transformers (which were operating on the secondary circuit) to delta.

By noting sketch it will be observed that if transformer a/a^{1} were disconnected from circuit (with delta connected secondary), it would not change the operation of the system, otherwise than to cut down its capacity 33 per cent (see case 1). If, however, secondaries are connected star, it is obvious that three-phase cannot be obtained inasmuch as line 2 and 3 only are connected to the source of energy with neutral (X) grounded. If, however, the connections of b^{1} are reversed its potential relation is changed to b^{11}, which gives a true open delta condition; line 2 then becomes line 2^{1}, and by changing the connections of the distributing transformers two-thirds of the original capacity can be obtained (see case 2).

JOURNAL OF ELECTRICITY
POWER AND GAS

PUBLISHED WEEKLY BY THE
Technical Publishing Company

E. B. STRONG, President
A. H. HALLORAN, Vice President and Managing Editor
C. L. CORY, Secretary.
DIRECTORS
R. J. DAVIS A. M. HUNT A. H. HALLORAN C. L. CORY E. B. STRONG
604 MISSION STREET, SAN FRANCISCO

EASTERN OFFICE, 150 NASSAU STREET, NEW YORK
C. N. MANFRED, Eastern Manager
LOS ANGELES OFFICE, 107 SECURITY BUILDING

TERMS OF SUBSCRIPTION

United States, Cuba and Mexico	per year,	$2.50
Dominion of Canada	"	3.50
Other Foreign Countries within the Postal Union	"	5.00
Single Copies, Current Month	each	.10
Single Copies, prior to Current Month	"	.25

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Changes of advertising copy should reach this office *ten days in advance of date of issue.* New advertisements will be accepted up to noon of Monday dated Saturday of the same week. Where proof is to be returned for approval, Eastern advertisers should mail copy at least thirty days in advance of date of issue.

Entered as second-class matter at the San Francisco Post Office as "The Electrical Journal," July 1895.
Entry changed to "The Journal of Electricity," September, 1895.
Entry changed to "The Journal of Electricity, Power and Gas," August 15, 1899.
Entry changed May 1, 1906, to "The Journal of Electricity, Power and Gas," Weekly.

FOUNDED 1887 AS THE
PACIFIC LUMBERMAN, CONTRACTOR AND ELECTRICIAN

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Fuel Economy

More power can be conserved by improving the economy of our developed steam plants than by withdrawing innumerable acres of undeveloped coal and oil lands or water-power sites. From ninety to ninety-five per cent of the energy in fuel is wasted. One-third is lost in smoke and one-half as exhaust steam. By saving even a part of this appalling loss we will benefit not only ourselves, but our posterity, who will blame us far more for our wasteful use of power than they will praise us for our conserving disuse. Economy in steam generation is dependent upon improving fuel combustion; saving in steam utilization may be effected by a low pressure turbine run with the exhaust steam.

Proper combustion is entirely a matter of air supply. Too little air causes carbon monoxide, which frees less than one-third as much heat as does carbon dioxide when it is formed. Too much air carries up the stack the heat that would otherwise be imparted to the water. The bad effects of excess air are usually under-estimated. If the owner of a power plant had to pay for his air as he does for his water, he would soon caution the fireman to use the minimum amount. But as his air costs nothing he continues blissfully ignorant of the fact that this free agent is regularly robbing the heat produced by burning at least one in every eight barrels of oil, until investigation of his fuel bill will show that there is nothing so expensive as what he gets for nothing.

Knowing the composition of a fuel it is easy to calculate the amount of air necessary for its combustion. Good practice allows an excess of fifty per cent. over this theoretical amount. Many plants, however, are using an excess of two hundred per cent. or more. Reducing this, means cutting down the fuel bill. There are three methods of determining how much air is being used: actual measurement with an anenometer, finding the heat loss by means of a pyrometer, or ascertaining its content in the flue gas, the last method being that most generally used. The percentage of carbon dioxide present is a reliable index of the amount of air passing through the furnace. Once that the correct percentage has been determined by an expert, it is merely necessary for the fireman to maintain it by adjusting his damper in accordance with the reading of some one of the mechanical carbon dioxide indicators that are on the market.

The low pressure steam turbine uses the energy in steam between exhaust pressure and that of a good vacuum, this energy not being used in the non-condensing reciprocating engine. As shown by Mr. L. R. Jorgensen in this issue, a combination of the turbine and the reciprocating engine effects great economy in steam utilization, which, together with the suggested saving in its generation, gives to the steam plant a much better rated efficiency. This is rational conservation.

PERSONALS.

F. A. Cressey, Jr., manager of the Modesto gas plant, is a San Francisco visitor.

John M. Klein, general manager of Mathias, Klein & Co., is visiting the Pacific Coast.

H. C. Keyes, president of the Natural Gas Company of Sacramento is at San Francisco.

Guy Sterling, an electrical engineer of Salt Lake City was a San Francisco visitor last week.

C. F. Conn, engineer with J. G. White & Co.'s San Francisco office, has gone to New York City.

Leon M. Hall of Hall, Demarest & Co., has returned from an inspection trip covering Merced and Virginia City.

J. W. White of the sales department of the Fort Wayne Electric Works, left last Tuesday for a trip to Nevada and Arizona.

F. A. Richards, who is in charge of the car and truck department of Pierson, Roeding & Co., left for Seattle last Tuesday.

A. M. Irwin, assistant to the treasurer of the Westinghouse Electric and Manufacturing Company, with headquarters at the San Francisco office, has returned from his summer vacation.

Delos A. Chappelle, who is interested in the hydroelectric company and other power enterprises in the interior of California, recently spent a day at San Francisco in consultation with his business associates.

Sidney Sprout, electrical engineer, has returned from a northern trip. Mr. Sprout, who has been located in the Crocker Building for some years, has just moved into more commodious offices—rooms 921 and 922.

O. A. Peterson, for several years with the General Electric Company at Lynn, Mass., and recently connected with the electrical department at the Bremerton Navy Yard, has arrived at San Francisco from Puget Sound.

Charles H. Gaunt, formerly superintendent of telegraph for the Santa Fe Railway, has been appointed general superintendent of the Western Union Telegraph Company, for California, Oregon, Washington, Idaho, Nevada, Utah, New Mexico, Arizona, and parts of Colorado and British Columbia, with headquarters at San Francisco.

S. F. T. Brock of Philadelphia recently arrived in San Francisco in connection with the reorganization of the Richmond Light & Power Company. Eastern capitalists have taken hold of this distributing concern which will serve Antioch, Martinez and several other towns besides Richmond. The capital stock has been increased from $300,000 to $2,500,000.

R. S. Masson of the Electric Operating & Construction Company, of New York, arrived last Saturday from the East and left for Prescott, Ariz., during the past week. His Arizona trip is connected with the taking over of the local electric lighting system in Prescott by the Arizona Power Company. The latter company has a hydroelectric plant, about forty miles from Prescott, which furnishes power for the Clark copper mines. The local steam plant has been purchased by the large concern which will engage in commercial lighting in future.

OBITUARY.

Charles S. Davidson, consulting electrical engineer with offices in San Francisco, died on the desert in Kern county, California, on June 17. Mr. Davidson was a graduate of the University of California in 1902. Two years ago he resigned as commercial agent for the Pacific Gas & Electric Company to take up consulting work which engaged his attention till his untimely death.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS AND ASSOCIATION OF RAILWAY TELEGRAPH SUPERINTENDENTS.

A joint meeting of the Los Angeles Section of American Institute of Electrical Engineers and the Association of Railway Telegraph Superintendents was held at Hotel Alexandria on Thursday, June 23, 1910, at 8 p. m. The wire crossing specification, which has been recommended for adoption by the Transmission Committee of the Railway Telegraph Superintendents, was the main subject discussed.

LOS ANGELES ELECTRICAL MEN'S PICNIC.

The second annual picnic of the electrical men of Los Angeles was held at Playa del Rey on June 11, 1910, with an estimated attendance of 550. The day was devoted chiefly to sports, the seven-inning baseball game between the Electrical Contractors vs. the Jobbers and the Manufacturers being won by the former with a score of 6 to 4. Other events were won as follows:

Throwing Baseball—1 B. C. Chase, 2 Mr. Wallace, 3 Mr. Towner.

Batting Baseball—1 Mr. Fleishman, 2 Mr. W. O. Spring, 3 Mr. R. Williams.

Running Broad Jump—1 Mr. Perry, 2 Mr. Fierce, 3 Mr. Hallet.

Standing Broad Jump—1 Mr. Rider, 2 Mr. Neir, 3 Mr. Hoag.

Race for Boys under 10 years—1 Harold Packman, 2 Fred Gilroy, 3 Joseph Warner.

Race for Girls under 10 years—1 Claudie Smith, 2 Margaret O'Connell, 3 Frances Porter.

Race for Boys under 16 years—1 Ernest Smith, 2 Harold Clark.

Race for Girls under 16 years—1 Verle George, 2 Bernice McCann, 3 Hallie Bowers.

Race for Fat Men—1 Mr. Frank R. Thomas, 2 Mr. T. M. Morris, 3 Mr. C. E. Warner.

Race for Stout Ladies—1 Mrs. Mina Hatlow, 2 Mrs. L. A. Duncan, 3 Mrs. Riley.

Dancing from 2 to 5. Free coffee and clam chowder were served at noon.

Potato Race for Ladies—1 Miss C. E. Allen, 2 Miss V. V. Venable, 3 Miss Callie Porter.

Egg and Spoon Race—1 Mrs. Ross, 2 Mrs. Warner, 3 Mrs. Porter.

Race for Heads of Commercial Houses—1 Mr. L. A. Duncan, 2 Mr. Bert Fanning, 3 Mr. Coffray.

Three-Legged Race—1 Harry George and George Larkey, 2 Bert Downer and Louis Kolb, 3 Eddie Weber and Robert Lanham.

Deep Sand Race for Ladies—1 Mrs. Gilroy, 2 Miss Black, 3 Miss Frank.

Sprinting Race for Real Sprinters—1 Mr. Spring, 2 Mr. Shaffer, 3 Mr. Berryman.

Tilting Race on Canal—1 Mr. Bowers and Mr. Warner, 2 Mr. Stetson and Mr. Hubbard, 3 Mr. Brown and Mr. Meek.

Swimming Race—1 Vernon Brown, 2 William Maddock, 3 G. Delman.

Bowling Tournament—1 Charles Sumner, 2 R. A. Thomas, 3 Cecil Meyer.

Bowling Highest Score—Van Runyan and Mr. Gross.

Chairman General Committee—Walter M. Fagan.

Finance Committee— C. B. Clapp and Harry Bowers.

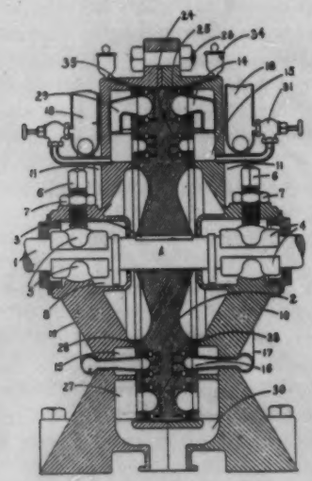
Sports Committee—George Cole (chairman), E. B. Clay, S. C. Purser, T. E. Berger, E. Woodbury and Van Runyan.

Ways and Means Committee—C. E. Warner (chairman), Mr. Baker, Mr. Woodward, Mr. Leavitt and Mr. Johnson.

Reception Committee—L. V. Benedict (chairman), C. Delman, Dick Northmore, Charles Coulter, Charles Hartung, N. W. Graham, Charles Carter and James Calkitt.

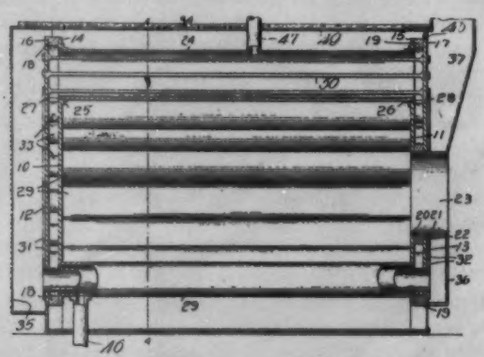
PATENTS

961,205. Reversible Steam-Turbine. Frank C. Beyerle, San Diego, Cal., assignor of one-half to R. M. Mobius, San Diego, Cal. In a device of the character described, the combination of a casing, of a power shaft journaled therein, of a rotative element mounted on the power shaft, of steam pockets formed within said rotative element, of annular and radial grooves, around said pockets of packing rings carried in said grooves, the said packing rings comprising annular concentric rings connected in pairs by short radial sections, and



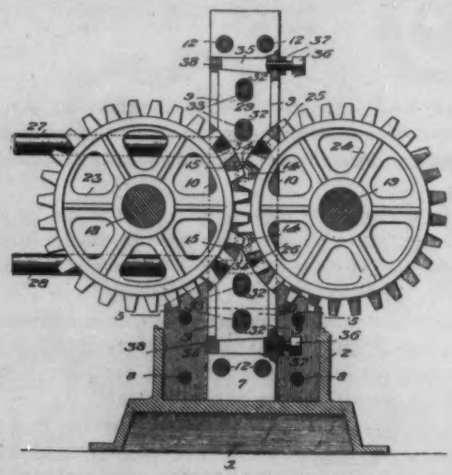
inner casings provided with inlet and exhaust ports, substantially as specified. In a device of the character described, the combination of a casing, of a power shaft journaled therein, of a rotative element mounted on the power shaft, of steam pockets formed within and upon opposite sides of the said rotative element, the impact surfaces of the pockets on one side facing in a direction opposite to those on the other side, of packing rings around said pockets, and inner casings provided with inlet and exhaust ports.

961,490. Steam-Generator. Robert J. Galbraith, Albany, Oregon. A steam generator comprising inner heads spaced apart and each provided with an upwardly directed extension, outer heads spaced from said inner heads and each provided with an upwardly directed extension, connecting means between each inner head and its extension and the adjacent



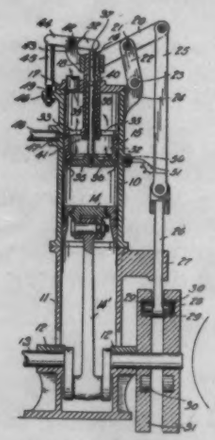
outer head and its extension and arranging the heads in pairs at each end of the generator, one of said spaced pairs having a fuel opening therethrough, a plurality of relatively small tubes connecting the inner heads near their peripheries and slightly apart with the tubes nearest the extensions spaced a greater distance apart, a plurality of flues connecting the outer heads and extending through the tubes which connect the inner heads, and a relatively large tube connecting the extension of the inner heads and above the large space between the upper tubes.

961,209. Fluid-Jet Motor. Clarence C. Cline, Oakland. Cal. In a motive fluid operated motor, the combination with rotary pistons having intermeshing vanes, of a casing in which the intermeshing vanes turn, means for directing opposing jets of the motive fluid to the intermeshing parts



of said pistons in a general transverse direction thereto, whereby friction on the pistons is neutralized, and an exhaust controlling valve movably mounted on the casing in position to regulate the exhaust at a point beyond the intermeshing vanes.

961,677. Internal-Combustion Engine. John W. Bradley, Seattle, Wash., assignor of one-half to Jacob E. Zickrick, Seattle, Wash. In a gas engine, a piston, a follower having movement independent of the piston, a by-pass extending



through said follower, a spring-closed valve for said by-pass, means operative from the engine shaft for reciprocating the follower, and means operative subsequent to the initial movement of the follower toward said piston for opening said valve for the escape of the spent gases through said by-pass.

INDUSTRIAL

A LOW TENSION PORTABLE TESTING OUTFIT

A small portable testing outfit, which the Westinghouse Electric and Manufacturing Company has recently developed, should appeal to the trade. There are continual calls about central stations, railway plants, car barns, repair shops, etc., for a portable testing device that will give an alternating voltage sufficiently high to test armature coils, meters, switches, and other details that are used in low tension systems and require an insulation test varying from 500 to 2000 volts. Such an outfit should be "fool-proof," as it must often be handled by men not familiar with high voltage; it should be semi-portable; it should afford a sufficient number of steps in the testing voltage; and last, but not least, it should be comparatively inexpensive.

The Westinghouse Company offers, for such service, a small bench-type, portable outfit, with a rating of .5-kw., which provides different testing voltages up to and including 2000 volts in 100-volt steps. It is designed for use on circuits

Low Tension Portable Testing Outfit.

of any frequency from 25 cycles up. Either a 110-volt or a 220-volt primary may be supplied. This capacity will be found sufficient for any normal testing up to 2000 volts. The 110-volt low-tension side may be connected to any source such as a lamp socket, walk receptacle, etc.

The neat wooden box in which the testing transformer is mounted is approximately 9½ inches by 12½ inches by 14¾ inches, and the weight is only 60 pounds. Two cast iron handles are provided so that the box can be very conveniently carried about.

The testing voltage is varied by means of two small rheostat dials mounted within the box. To the contacts of the dial are brought the taps from the high-tension winding of the transformer. Any voltage from 100 to 2000 volts can be obtained in 100 volt steps.

The rheostat dials, as well as the high-tension binding posts, are mounted within the box. When the hinged cover is lifted to change the dial setting, the low-tension primary circuit is automatically opened, so that the box is absolutely "fool-proof" against any touching of the dials, binding posts, etc., while the transformer is excited. Two high-tension testing leads consisting of rubber covered cable, passing through rubber tubing, are brought out of the box and provided with heavily insulated terminals so that they may be handled with perfect safety by the tester.

A pilot lamp, connected across the low-tension primary circuit and mounted on top of the box, promptly indicates when the primary circuit is closed. A plug switch and fuse holder are provided in the primary to protect and control the circuit.

PRIZES AT LOS ANGELES ELECTRIC MEN'S PICNIC.

Prizes were donated as follows: American Elec. Novelty & Manufacturing Co., one thermos bottle; American Steel & Wire Co., cash, $5; Boston Woven Hose & Rubber Co., cash, $2; Cole Co., John R., cash, $10; Consolidated Electric Co., one 5-lb. iron; Cook Electric Co., one radiometer; Dodds-Caffray Co., cash, $5; Eccles & Smith, cash, $5; Electrical Supply Co., one desk lamp; Fairbanks-Morse Co., cash, $5; Forve-Pettibone Co., cash, $5; Foulkes-Gaylord Co., one disc heater; Gans Bros., one battery fan motor; General Electric Co., cash, $10; General Electric Co., one coffee percolator; General Electric Co., one baby milk warmer; Holabird- Reynolds Elec. Co., hot point utility set; Holabird-Reynolds Elec. Co., cash, $5; Home Tel. & Tel. Co., cash, $5; Hutchinson Co., W. G., one desk, portable; Ideal Elec. Co., two Hylo lamps; Illinois Electric Co., cash, $2.50; Industrial Elec. Co., cash, $5; Johns-Manville Co., cash, $5; Johns-Manville Co., one Electrotherm; Kellogg Switchboard & Supply Co., cash, $10; Kierulff & Co., B. F., cash, $5, one 100-watt tungsten; Leavitt-Bartholomew Co., one piano lamp, one brass jardinier; Lion Elec. Co., one desk, portable; Los Angeles Gas & Elec. Corporation, cash, $10; Meyberg Co., one desk, portable; Mission Mixture Co., one desk, portable; Murray, F. E., cash, $5; The National Conduit & Cable Co., cash, $5; Newberry-Bowers Elec, Co., cash, $5, one electric shaving mug; Pacific Light & Power Co., cash, $10; Pacific States Electric Co., cash, $5, one G. E. iron; Pacific Electric Heating Co., one automatic iron; Parmelee & Co., Z. L., one table lamp, one candlestick; Parmelee-Dohrmann Co., one vase; Pass & Seymour, cash, $5; Roebling's Sons Co., John A., cash, $5; Southern California Edison Co., cash, $10; Southern California Electric Co., one electric toaster; Standard Underground Cable Co., cash, $5; U. S. Long Distance Tel. & Tel. Co., cash, $5; U. S. Elec. Manufacturing Co., one sewing machine motor; Western Electric Co., six curling irons; Westinghouse Elec. & Mfg. Co., cash, $5, one electric stove toaster; Wilson Co., E. A., one desk, portable; Woodill & Hulse Electric Co., two nickel flash lights, cash, $5.

TRADE NOTES.

Hunt, Mirk & Co., have the contract to install additional turbo generators in the Phelan Building basement for the Equitable Light & Power Company.

The Decker Electric Company's bid of $46,000 was the lowest of a number submitted last week for a government contract in connection with the introduction of electric lighting at the Presidio of San Francisco. The construction of a pole line, sub-station and the wiring of several buildings were included in the specifications.

The Pelton Water Wheel Company is constructing for the Pacific Light and Power Company's Burrell power station, in the Kern River Canyon, a Pelton-Francis turbine wheel to develop 3600-h.p. under a head of 250 feet. The new wheel is direct connected to an alternator operating at 231 r.p.m. There are five generating units in operation at the plant.

NEWS NOTES

INCORPORATIONS.

VISALIA, CAL.—The Tulare County Power Company has been incorporated by J. J. Vosburg, C. H. Holly and H. H. Holly with a capital stock of $1,000,000.

SEATTLE, WASH.—The West Coast Power Company, capital $50,000, has been incorporated by J. E. Wickstrom, Central Building, Emory E. Hess and others.

SANTA ANA, CAL.—The Home Tract Water Company has been incorporated by W. H. Wells, G. F. Cochrane, R. C. Launders, J. G. Dunn and E. Crane, with a capital stock of $20,000.

SALEM, ORE.—The Southern Oregon Railway & Power Company has been incorporated by John R. Allen and others for $5,000,000 for the purpose of building electric railways, power plants, etc., in the Rogue river valley.

TRANSPORTATION.

BAKER CITY, ORE.—Anthony Mohr has been granted a franchise to construct a street railway here.

PERRIS, CAL.—Regarding the proposed electric railroad from Oak Cliff to Valle Vista, thence to Hemet, San Jacinto and Morento, J. S. Jackson, who asked, for the franchise, has temporarily withdrawn it.

OLYMPIA, WASH.—The $15,000 bonus required by the Olympia Light & Power Company for the extension of its system to the West Side has been raised, and it is expected that by September operations will be under way.

PORTLAND, ORE.—Final survey of the United Railway route through to Tillamook bay has been approved by President John F. Stevens, and contracting firms are now going over the proposed line for the purpose of preparing bids on construction.

RIVERSIDE, CAL.—The Riverside Portland Cement Company, which is extending the Crescent Railway line from its plant northward to Bloomington on the Southern Pacific, will secure rights of way for a further extension to Rialto. The road will be operated as a trolley line.

OAKLAND, CAL.—The Central Pacific, as a subsidiary of the S. P. Company, has filed application with the City Council for a franchise permitting the extension of its local ferry service through Melrose. The application asks that the company be allowed to extend its ferry service road from its present terminal to the Stanley road, the eastern boundary of the city.

LOS ANGELES, CAL.—The Public Welfare Committee has held a hearing on the petition of property owners to have a strip of land 200 feet in width on the south side of Agricultural Park condemned for park purposes. The property owners pointed out that one of the local railway companies contemplate using the land in question for a spur track and car barns, which will injure residential property. The committee took the matter under advisement.

OAKLAND, CAL.—The Oakland Traction Company has been censured by the jury sitting at the inquest held by County Coroner C. L. Tisdale to inquire into the causes of the wreck at Leona Heights on Decoration Day. The gist of the verdict rendered is to the effect that the company and the motorman and the conductor of car No. 251 were equally to blame for the disaster which cost the lives of five persons. The conductor was censured for neglecting to inspect the registry book, and the company for running crowded cars on a single track, without a block system.

SAN FRANCISCO, CAL.—Morrison & Brobeck, the attorneys for Horace G. Platt, the plaintiff in the Geary street municipal railroad case, have filed their reply brief in the Supreme Court, where the case is now pending on appeal from the decision in favor of the city. The point on which the appellant appears to rely in this reply brief is the claim that in the section of the city charter relating to the acquisition of a street railroad property by the city there is a clause permitting the sale or lease of the property by the city after the road comes into possession of the munipality. The argument is made that this clause is unconstitutional, and that, therefore, the whole section is void.

FRESNO, CAL.—At a conference of business men, who are interested in the proposed electric railroad between Fresno and Monterey, it was decided to incorporate a company with a capitalization of $4,000,000 and to begin construction work within 60 days. It is hoped to complete the road as far as Coalinga in nine months and connect Fresno with tidewater in two years. Those in attendance at the session were Judge Kerr and A. P. May of Coalinga, A. G. Metz and H. N. O'Bryan of Monterey; A. B. Harris and A. B. Weller, attorneys of San Francisco, and George Chalmers and E. R. Shaw, railroad men of San Francisco. Among the Fresnoans interested is Dr. W. T. Burks. From the oil fields of Coalinga the road will pass through Pinoche Pass, touching Tres Pinos, Hollister, Salinas and Monterey. From Coalinga the survey leads directly across the plains to this city.

TRANSMISSION.

SPOKANE, WASH.—The Washington Water Power Company plans to overhaul and improve its network of overhead wires.

ST. MARIES, IDAHO.—The St. Maries Light & Power Company is preparing to build a $35,000 power plant on the St. Maries river.

PRINCETON, CAL.—Preparations are being made by the Northern California Power Company to extend its lines from Hamilton City to Jacinto, where the power is to be used for the operation of irrigating pumps.

NEWPORT, WASH.—The Washington Water Power Company will build a high tension line from its power plant at Little Falls on the Spokane river, a distance of 70 miles, at a cost of $150,000. This is for the purpose of furnishing light and power to various towns along the line.

BERKELEY, CAL.—The Berkeley City Council has officially acknowledged the petition of the Great Western Power Company, which seeks a franchise in the city for the operation of its plant and the sale of electric current, by setting Tuesday, July 19th, as the day on which the franchise shall be disposed of to the highest bidder as provided by the new city charter. In granting the franchise the Council will reserve the right to specify the rates, and to name the districts in which wires shall be placed underground.

OROVILLE, CAL.—The Great Western Power Company has begun work on the dam across the Feather river, above the head of the tunnel, in the Big Bend, 30 miles from this city. Four hundred men will be put at work at once, and this force will be increased to 1200. The power company had planned to begin work on the dam early this spring but, owing to the difficulty of finding good foundations, the commencement of operations was delayed. There was no difficulty in finding a good foundation in the river, but the trouble lay in the banks, as the foundation was not suitable for the permanency of a dam 150 feet high.

ILLUMINATION.

PETALUMA, CAL.—The plans for the new gas plant in this city have been received by local manager Weber and approved by Engineer Jones.

WILLOWS, CAL.—An official of the Northern California Power Company says that the company will install a gas plant in Willows within a short time.

EDGEWOOD, CAL.—The Edgewood electric light plant is running night and day now. The day load consists of fans, irons and small motors. R. E. Cavanaugh is planning to enlarge the plant.

BAKERSFIELD, CAL.—McFarland and the country adjacent is to be supplied with electric power and lights, according to plans formed by the Mount Whitney Power and Electric Company.

REDMOND, ORE.—Sixteen business men at Redmond have formed a company for the purpose of installing an electric light plant there. The name of the company will be the Crook County Light & Power Company.

POCATELLO, IDAHO.—That Pocatello is to have gas for lighting and heating has been announced by J. A. Jones of Chicago, Ill., who has been granted a 25-year franchise to lay mains through the streets. The construction of the plant is to begin immediately.

MONROVIA, CAL.—The Piedmont Gas Company is preparing to extend its mains from Monrovia to Arcadia and Sierra Madre and throughout those two towns. It is estimated that the extension will necessitate the laying of 153,000 feet of pipe, covering a distance of approximately 28 miles.

LOS ANGELES, CAL.—Within 30 days the local offices of the Southern California Edison Company and Inner Harbor Gas Company, of Long Beach, will be merged into the Long Beach Consolidated Gas Company. A plant which will be a distributing center for Long Beach and cities near by will be erected.

SOUTH BEND, WASH.—The South Bend Electric Company has made application to the Board of County Commissioners for Pacific County, Wash., for a franchise to erect, maintain and operate lines for the supply of electric current for lighting and other purposes in the streets and alleys and public places of Eklund Park .

LOS ANGELES, CAL.—Failure on the part of the light and power companies to submit bids for ornamental lighting of W. Pico street may compel property owners on that thoroughfare to install meters on every post in order to secure lighting. The post meter plan has been suggested as a solution because light companies can be compelled to supply current in that way.

NEWPORT, WASH.—The Northern Idaho & Montana Power Company, which operates electric light and power plants between Kalispell, Montana, and Newport, Wash., has made a contract for electric current with the Washington Water Power Company of Spokane to provide light and power for the cities of Newport, Sandpoint and the intervening points. The contract runs for ten years.

SAN FRANCISCO, CAL.—The San Francisco Gas & Electric Company has filed its annual application in the United States Circuit Court, asking for an injunction restraining the City and County of San Francisco from collecting rates on the schedule fixed by the Board of Supervisors. The grounds are similar to those put forward in their application of last year and they claim that the rate of 85 cents to consumers is confiscatory. It is claimed that under the Fourteenth amendment the company is entitled to get a fair return on its investment. The company is now collecting $1 from consumers, 15 cents of which is impounded with the clerk of the court, pending the final decision of the first action.

REDLANDS, CAL.—The San Bernardino Valley Gas Company of Redlands has been forced into involuntary bankrutcy by the filing of a petition in the Federal Court of Los Angeles by the creditors, the largest of which is the Home Gas & Electric Company of this city, J. F. Dostal, and C. S. Chestnut, assignee Paul W. Moore. The petition specifically alleged that the company borrowed from the Home Gas Company, $25,000, giving stock as security, and has paid no interest since last September. The San Bernardino Gas Company was financed the first part of the year in Los Angeles with the purpose of controlling the gas business in this section of the valley. It was headed by J. M. Gardiner, and since its inception has not been a success. In July, after having secured the Home Gas & Electric Company property in this city the company took charge of affairs here and since then has been in charge of the business.

LOS ANGELES, CAL.—That the directors of the Southern California Gas Circuit Company practiced fraud and deceit in the sale of stock in their company to Frank Campbell, a director in the Bank of Glendale are charges contained in a complaint filed in the Superior Court asking for a judgment of $6500 against the company. In addition to his own interests, Campbell states that others lost money through the same transaction. The defendants in the suit are Berthold Baruch, Herman Cohn, Jas. W. Hellman, Max N. Newmark and S. T. Mock. It is alleged that after securing from the city trustees permission to lay gas pipes in the streets of Glendale, the original board of directors voted themselves $80,000 of a capital stock of $150,000 which had been subscribed. Immediately after this Adolph Gensiein and R. A. Blackburn quit the company, their places on the board being taken by Baruch and Newmark, who had no hand in the original transfer of the stock.

PASADENA, CAL.—The struggle between this city and the Edison Electric Company over lighting was renewed when the city cut the rate at its municipal plant to 5c per kilowatt hour. Nearby cities like South Pasadena and Alhambra pay 12½c. The Edison company charged the latter rate in Pasadena until a few months ago, when, with the idea, the city claimed, that it might put the municipal plant out of business, it slashed to 5c. The city has now met the cut and the officials say the plant can sell at the cheap rate and still make money, provided the number of customers is increased from 2125 to 4000. A vigorous campaign was begun by municipal ownership advocates to get the number desired. City Attorney J. P. Wood stated that on the 5c. basis, with 4000 customers, they could pay operating expenses, provide for payment of principal and interest of the bonds and lay aside a considerable sum for new construction. As soon as the Edison people learned that Pasadena intended to cut the price to 5c per kw. hour they announced a reduction to 4c.

SAN BERNARDINO, CAL.—The Home Gas and Electric Company of Redlands will file another suit against the city of Colton for the $50,000 damages alleged to have been sustained by that corporation for the alleged refusal of the city of Colton to carry out the electric lighting contract made with Seth Hartley October 2, 1907, and assigned by Hartley to the Redlands corporation. Some months ago a similar suit was filed by the Redlands company against Colton, but was non-suited in the Superior Court here on the ground that no evidence had been produced to show that the Colton city trustees had ever ratified the Hartley contract. Attorney Halsey W. Allen of Redlands paved the way for the second suit when he filed a demand with the city of Colton for damages in the sum of $50,000. The demand after reciting the history of the affair, gives three grounds for making the demand for damages: First, that the city of Colton has renounced its obligation and repudiated the contract; second, that it has refused to allow the lighting company to perform the conditions required in the contract; third, that the city of Colton has refused to pay any sum due under the contract.

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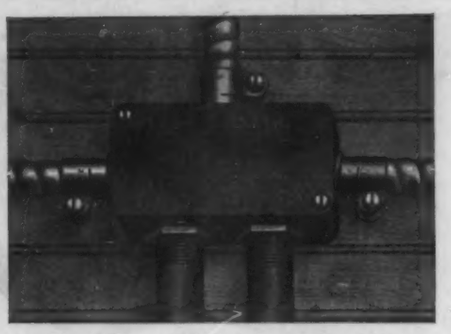

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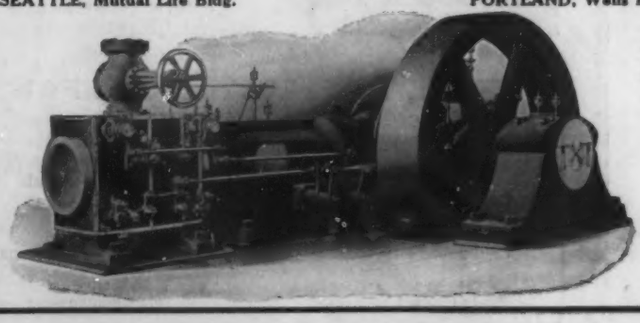

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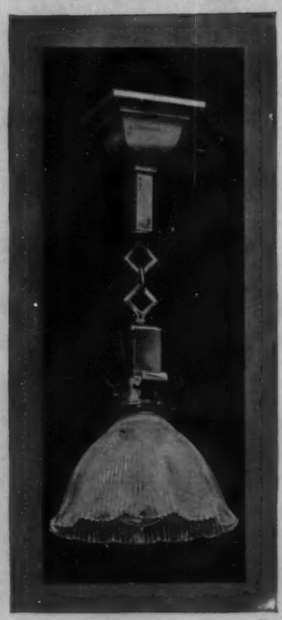

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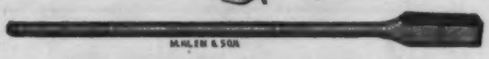

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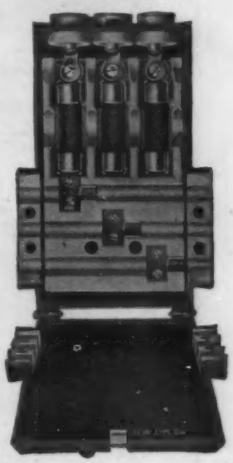

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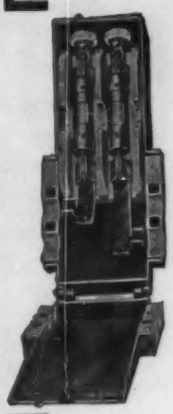

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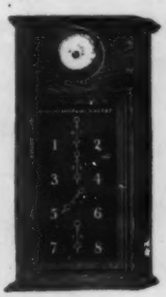

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CLUSTERS

Fixture Clusters

Benjamin Electric Mfg. Co. "Anti-Night."
General Electric Co.

COILS

Armature and Field Coils

D. & W. Fuse Co.
General Electric Co.
Westghse Elec. & Mfg. Co.

Induction Coils

Electric Goods Mfg. Co.
Kellogg Switchboard and Supply Co.
Partrick,Carter&WilkinsCo.

Spark Coils

Electric Goods Mfg. Co.

COMPOUNDS

Boiler Compounds

Dearborn Drug & Chemical Works
Johns-Manville Co., H. W., "Magic."

CONDUIT

Flexible Conduit

American Circular Loom Co., "Circular Loom."
Sprague Electric Co., "Greenfield."
Telephone & Elec.Equip.Co. "Flexduct."

Rigid Conduit

American Circular Loom Co., "Electroduct."
Kieruliff, B. F., Jr. & Co., "American."
Sprague Electric Co., "Iron Armored."
Telephone & Elec.Equip.Co. "Economy."

Underground Conduit

Johns-Manville Co., H. W., "J-M."
Pierson, Roeding & Co., "Fibre."

CONNECTORS

Cable Connectors

American Ever Ready Co. "Bulldog."
Kieruliff, B. F., Jr. & Co.

CORD

Flexible Bell Cord

General Electric Co.
Kieruliff, B. F., Jr. & Co., "National."
Pierson, Roeding & Co., Agents, Elec. Cable Co.
Simplex Elec. Co.

Lamp Cord

General Electric Co.
Okonite Co., The, "Okonite."
Pierson, Roeding & Co., Agents, Elec. Cable Co.
Simplex Elec. Co.
Sprague Electric Co.
Standard Und. Cable Co.

Telephone Cord.

Kellogg Switchboard and Supply Co.
Kieruliff, B. F., Jr. & Co., "National."
Pierson, Roeding & Co., Agents, Elec. Cable Co.
Simplex Elec. Co.

CROSS ARM BRACES.

Kieruliff, B. F., Jr. & Co.

CUT-OUTS

Arc Cut-Outs

Bryant Electric Co.
Ft. Wayne Elec. Works.
General Electric Co.
Parrott & Co., "Fox."

Incandescent Cut-Outs

Bryant Electric Co.
D. & W. Fuse Co.
General Electric Co.
Paiste Co., H. T., "Shaffer," "K. W.," "P. K.," "Tap-lets."
Perkins Elec. Swch Mfg Co.
Westghse Elec. & Mfg. Co.

Transformer Cut-Outs

Bryant Electric Co.
D. & W. Fuse Co.
General Electric Co.
Parrott & Co., "Peerless."
Westghse Elec. & Mfg. Co.

DYNAMOS

A. C. Dynamos

Ft. Wayne Elec. Works.
General Electric Co.
Standard Engineering Co.
Westghse Elec. & Mfg. Co.

D. C. Dynamos

Ft. Wayne Elec. Works.
General Electric Co.
Parrott & Co., "Diehl."
Sprague Electric Co.
Standard Engineering Co.
Westghse Elec. & Mfg. Co.

DYNAMOMETERS.

Sprague Electric Co.

ELECTRIC HOISTS.

Sprague Electric Co.

ELECTRIC NOVELTIES

American Electrical Heater Co.
American Ever Ready Co. "Ever Ready."

ENGINES

Gas and Gasoline Engines

Moore & Co., Chas. C.
Henshaw-Bulkley & Co.
Hunt, Mirk & Co., "Westinghouse."
Kieruliff, B. F., Jr. & Co., "American Diesel."
Tracy Engineering Co.
Westinghouse Machine Co.

Marine Engines

Standard Engineering Co., "Engberg."

Steam Engines

Moore & Co., Chas. C.
Hunt, Mirk & Co., "Westinghouse."
Standard Engineering Co.
Tracy Engineering Co., The
Westinghouse Machine Co.

FANS

A. C. Portable Fans

Ft. Wayne Elec. Works.
General Electric Co., "G. E."
Standard Electric Works, "Jandus."
Westghse Elec. & Mfg. Co.

D. C. Portable Fans

Ft. Wayne Elec. Works.
General Electric Co., "G. E."
Parrott & Co., "Diehl."
Sprague Electric Co., "Lundell."
Standard Electrical Works, "Jandus."
Westghse Elec. & Mfg. Co.

A. C. Ceiling Fans

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Westghse Elec. & Mfg. Co.

D. C. Ceiling Fans

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Parrott & Co., "Diehl."
Sprague Electric Co., "Lundell."
Standard Elec. Works, "Jandus."
Westghse Elec. & Mfg. Co.

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General Electric Co.
Parrott & Co., "Kimball."
Standard Elec. Wks., "M. A. Co."
Westghse Elec. & Mfg. Co.

FIXTURES

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Benjamin Elec. Mfg. Co.

Show Case Fixtures

Benjamin Elec. Mfg. Co.
Johns-Manville Co., H. W., "Linolite."

FLASHLIGHT (Pocket)

American Ever Ready Co. "Ever Ready."

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Enclosed Fuses and Fittings

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D. & W. Fuse Co.
General Electric Co.
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Westghse Elec. & Mfg. Co.

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Pierson, Roeding & Co. "Aluminum."

Miscellaneous Fuses

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General Electric Co.
Paiste, H. T. Co., "H. & L."

Telephone Fuses

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Kieruliff, B. F., Jr. & Co., "Sterling."
Standard Elec. Works "Couch & Seeley."

GOVERNORS.

Water-Wheel Governors

Pierson, Roeding & Co., "Lombard."

GUARDS.

Wire Lamp Guards.

Benjamin Electric Mfg. Co "Can't Break," "Protectalite."

HANGERS

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Armored.

Sprague Electric Co.

HOODS.

Street Hoods

Ft. Wayne Elec. Works.
General Electric Co.
Kieruliff, B. F., Jr. & Co "Cutter."

INSULATORS

Glass Insulators

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Pierson, Roeding & Co. "Locke Triple Petticoat"
Standard Electrical Wor "Standard."

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Kieruiff, B. F., Jr. & Co., "Ohio Brass."
Pierson, Roeding & Co., "Locke."
Thomas & Sons Co., R.

Porcelain Insulators

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Pierson, Roeding & Co., "Locke."
Standard Electrical Works, "Standard."
Star Porcelain Co.
Thomas & Sons Co., R.

Wood Knobs

Blake Signal & Mfg. Co.

INSULATING MATERIAL.

Kieruiff, B. F., Jr. & Co., "Di-electric."
Johns-Manville Co., H. W. "Asbestos Wood," "Indurated Fibre," "Vulcabeston," "Monarch," Phoenix," "Electrobestos."
Standard Underground Cable Co., "Ozite."

LAMPS.

Electric Arc Lamps

Ft. Wayne Electric Works "Wood."
General Electric Co., "G. E."
Parrott & Co., "Radiante Economy."
Standard Electrical Works, "Jandus," "Boulevard."
Westghse Elec. & Mfg. Co.

Flaming Arc Lamps

General Electric Co., "G. I."
Parrott & Co., "Grant."
Westghse Elec. & Mfg. Co.

Incandescent Lamps

California Inc. Lamp Co., "California."
General Elec. Co., "Edison."
Johns-Manville Co., H. W., "Linolite."
Kieruiff, B. F., Jr. & Co., "Excelsior."
Westghse Elec. & Mfg. Co. "Westinghouse."

Miniature Lamps.

American Ever Ready Co. "Ever Ready."
General Electric Co.

Tantalum Lamps

General Elec. Co., "Meridian," "Tantalum."
General Electric Co.
Kieruiff, B. F., Jr. & Co., "Excelsior."

Tungsten Lamps

California Inc. Lamp Co., "California."
General Electric Co.
Johns-Manville Co., H. W.
Kieruiff, B. F., Jr. & Co., "Excelsior."
Parrott & Co., "Kimball."
Westghse Elec. & Mfg. Co.

LINE MATERIAL.

Street Ry. Line Material

General Electric Co.
Johns-Manville Co., H. W., "J-M."
Kieruiff, B. F., Jr. & Co., "Lord Electric Co."
Pierson, Roeding & Co., "Ohio Brass Co."
Westghse Elec. & Mfg. Co.

MACHINES

Refrigerating Machines

Vulcan Iron Works

MINING

Mining Machinery

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Henshaw, Bulkley & Co.
Moore & Co., Chas. C.
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Ammeters and Voltmeters

American Ever Ready Co. "Every Ready."
Ft. Wayne Elec. Works, "Wood."
General Electric Co.
Johns-Manville Co., H. W., "Victor Combination."
Westghse Elec. & Mfg. Co.
Weston Elec. Instmt. Co.

Gas Meters

Pacific Meter Co.

Wattmeters

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Ft. Wayne Electric Works.
General Electric Co.
Johns-Manville Co., H. W.
Weston Elec. Instmt. Co.
Westghse Elec. & Mfg. Co.

MOTORS

A. C. Motors

Crocker-Wheeler Co.
General Electric Co.
Kieruiff, Jr., & Co., B. F., "Ideal."
Parrott & Co., "Kimball."
Standard Electrical Works, "Century."
Telephone & Elec.Equip.Co. "Holtzer-Cabot."
Westghse Elec. & Mfg. Co.

D. C. Motors

Crocker-Wheeler Co.
Ft. Wayne Electric Works.
General Electric Co.
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Sprague Electric Co.
Standard Electrical Works, "Century."
Telephone & Elec.Equip.Co. "Holtzer-Cabot."
Westghse Elec. & Mfg. Co.

MOULDING

American Circular Loom Co., "Lutz."
Johns-Manville Co., H. W., "Electrobestos."

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Insulating Paint

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Standard Underground Cable Co., "Ozite."

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Thomas & Sons Co., The R., "Lee."

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PIPE.

Iron and Steel Pipe.

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PLUGS.

Attachment Plugs.

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Flush Plugs

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Stage Plugs

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General Elec. Co.
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Standard Electrical Works, "Union."

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Standard Electrical Works, "Union."
Westghse Elec. & Mfg. Co.

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Kieruiff, B. F., Jr. & Co., "Dielectric."
Standard Electrical Works, "Standard."

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TAPE

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Kieruiff, B. F., Jr. & Co., "Imperial."
N. Y. Insulated Wire Co., "Grimshaw," "Competition."
Okonite Co., The, "Okonite," "Manson."
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American Ever Ready Co "Ever Ready."

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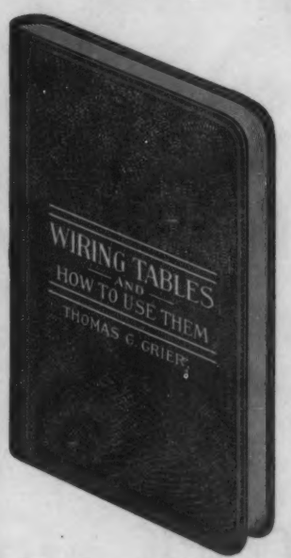

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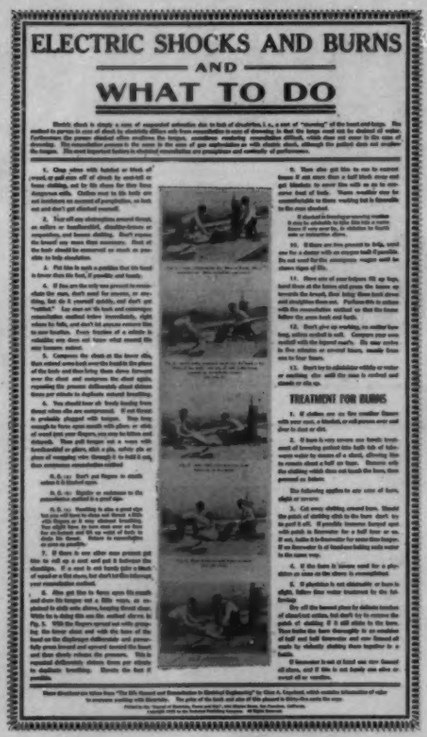
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BY CLEM A. COPELAND

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2308

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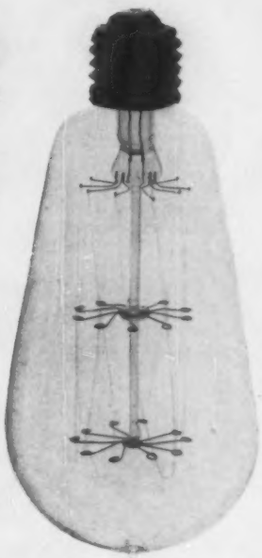

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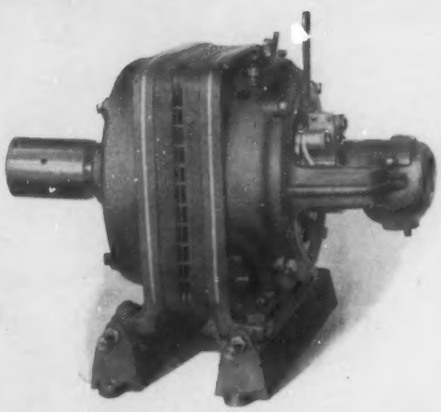

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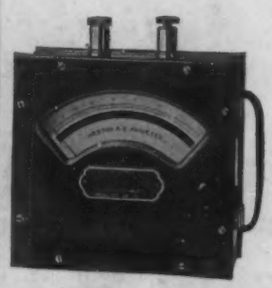

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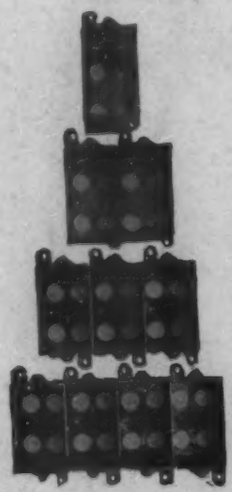

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